Delta Design®
A Cohu Company

INSTRUCTION MANUAL

DELTA DESIGN, INC.
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POWAY, CALIFORNIA 92064-6817
FAX: (858) 848-8180
PHONE: (858) 848-8000

7/18/2005

9010 TEMPERATURE CONTROLLER RETROFIT

FOR OLDER MODEL DELTA DESIGN CHAMBERS

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ENVIRONMENTAL CONTROL EQUIPMENT FOR RESEARCH AND INDUSTRY
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B

ADDENDUM FOR THE 8816 SOFTWARE VERSION

LIST OF DEFAULTS:

Setpoint	25.0 degrees
High Temp Limit	220.0 degrees
Low Temp Limit	-60.0 degrees
GPIB Address	27
RS-232 Baud	9600
Calibration Points	none
Rate Program:	
Set Temp #1	-55.0 degrees
Set Temp #2	50.0 degrees
Set Temp #3	105.0 degrees
Set Temp #4	210.0 degrees
All other parameters	0.0

Gains:

TYPE	PGAIN	IGAIN
9023	6	3
9028	6	4
9039	7	4
9059	7	5
9064	7	5
9076	7	5
9080	7	5
9145	7	5

OPERATIONAL CHANGES

The SW1-2 modes can now be entered thru the front panel by pressing both the FCN and UP keys while all segments are on after power-up. If Full Access is allowed by SW1-3, all Rate Programmer parameters will be available from the front panel. If Full Access is inhibited, the controller will come up in Normal Access but with the Rate Programmer temperature list selectable as set-points.

The LCD will blink the message "LOP" three times on power-up if there has been a loss of parameters. This can happen if the battery backup has failed, or deliberately by holding in the FCN, UP and DOWN keys at power-up. Loss of parameters means that the default values have been loaded after clearing all of RAM.

WARRANTY

Delta Design, Inc., warrants all products it manufactures and sells against defective material and workmanship for a period of 90 days from the date of our shipment. Temperature chambers and electronics are warranted for one year from the date of our shipment. All contactor assemblies are warranted for a period of 90 days or 1/2 million cycles.

Obligation under this warranty is limited to repair at the factory (5775 Kearny Villa Rd., San Diego, CA 92123), or one of our authorized service stations, or at our option, replacement of any product Delta Design determines to be defective or not in accord with stated specifications. All replacement parts will be invoiced and credit issued upon acceptance of defective part.

Delta Design will not accept responsibility for any defect caused by improper use, nor will Delta Design assume liability for any unauthorized repairs or modifications to its products or materials, even though defective or not in accord with the specifications. In no case will responsibility extend to products, materials, or equipment not manufactured by Delta Design.

All products to be returned to Delta's plant for warranty repair must have prior approval from from Delta Design, Inc. Delta Design will not accept liability for any unauthorized returns. Transportation for the return of the repaired equipment to the customer shall be prepaid by Delta Design. Delta Design will not allow any credit for repairs or alterations to its products, and Delta Design shall in no event assume any responsibility for repairs or alterations made other than by Delta Design. Any products repaired or replaced under this Warranty will be warranted for the balance of the warranty period remaining with respect to the original purchased product.

All products to be returned to Delta's plant for non-warranty repair must have prior approval from Delta Design, Inc., and all transportation charges, incoming and outgoing, will be at the buyer's expense. Delta Design will not accept liability for any unauthorized returns. Delta Design shall in no event assume any responsibility for repairs or alterations made other than by Delta Design. Any products repaired or replaced under this section of the Warranty, will be warranted for 90 days from the date of our return shipment.

ADDED REMOTE COMMANDS:

TYpe?	Returns the "9XXX" chamber type selected by the front panel dip switches. Returns "0000" if an invalid selection.
OUT2 ON	A second unassigned output at J3 on the Chamber AC board. The other at J6 is controlled with the "Output ON/OFF" commands. Both are +5 on power-up or when "OFF", and pulled to GND when "ON".
OUT2 OFf	

No liability will be accepted for any damages to customer's materials and equipment due to the use or misuse of Delta's products, nor for any loss of profits or other special damages.

Representations or Warranties that are inconsistent with this Warranty made by any person, including employees or representatives of Delta Design, shall not be binding on Delta Design. Delta Design, Inc., reserves the right to change price, design features and/or specifications without notice.

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Specifications remain subject to change to allow the introduction of design improvements.

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9010 TEMPERATURE CONTROLLER RETROFIT

1.1 GENERAL

The Delta Design, Inc., 9010 Temperature Controller is offered in all new 9000 Series Environmental Chambers, as well as being offered as a retrofit for all old Delta Chambers. As a retrofit, some modification of the chamber may be required to mount and install the new controller. Installation and mounting instructions are as follows.

1.2 UNPACKING

Before starting the conversion process, insure that the Retrofit Kit supplied by Delta Design is complete according to the Retrofit Kit Parts List (located in the back of this manual). If any item is missing, please call the Delta Design Sales Department with the part numbers of missing items, in order to facilitate a quick replacement.

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PHONE: (619) 292-5000

Unpack all components, inspect and check off each item according to the parts list, and set aside.

1.3 PRECAUTIONS

Read and understand all of the following instructions BEFORE taking any action. Examine all the reference documents for complete understanding of the circuits and components being connected, BEFORE making any connections.

NOTE

UNPLUG THE POWER FROM THE CHAMBER.

2.1 9010 RETROFIT INSTRUCTIONS

NOTE

If your chamber does not have a circuit breaker or ASCO valve CO2 or LN2, you need to order them.

2.1.1 Perform the following steps in the order listed.

1. Disconnect chamber from AC power.

2. Remove right side panel from chamber (this is the panel on the right when facing the front of the chamber).

3. Remove the controller and the controller harness (located between the controller and TB1 terminal block on the chamber), including the harness wires that are connected to the rear panel.

4. Remove the rear panel from the chamber and disconnect all the wires from TB1 that go to the rear panel.

5. Remove the line cord and circuit breaker from the old back panel (the one just removed), and install it on the new back panel.

NOTE

If your chamber has line filters, discard them.

6. Disconnect the failsafe wires from TB1 and remove the failsafe light from the front panel (disconnect wires at the wirenut point).

7. Remove the K1 relay and the wiring between the relay and TB1 terminal block.

NOTE

For steps 8, 9, and 10 refer to your old chamber wiring schematic to ensure that you have the proper heater wires.

8. Remove the heater wire from TB1-8 and mark it #14.

9. Remove the heater wire from TB1-7 and mark it #12.

10. Remove the heater wire from TB1-6 and mark it #11.

NOTE

Steps 11 and 12 are only for chambers with single blower motor connection for 120 VAC.

11. Remove the motor wire from TB1-3 and mark it #1.

12. Remove the second motor wire from TB1-4 and mark it #5.

NOTE

Steps 13 and 14 are only for chambers with double blower motor connections for 120 VAC.

13. Remove the motor wire from TB1-3 and mark it #1.

14. There are two wires on TB1-4, one to each motor. Remove and mark one wire #5 and the second wire #6 (it does not matter which one is on #5 or #6).

NOTE

Steps 15, 16 and 17 are only for chambers with blower motor connection for 240 VAC.

15. Remove the black wire on the transformer (T-1) from TB1-2 and mark it #1.

16. Remove the red wire on the transformer (T-1) from TB1-3 and mark it #4.

17. Remove the red and white wire on the transformer (T-1) from TB1-4 and mark it #6.

NOTE

Steps 18 and 19 are only for chambers with single blower motor connection for 240 VAC.

18. Remove the blower motor wire from TB1-3 and mark it #3.

19. Remove the blower motor wire from TB1-4 and mark it #5.

NOTE

Steps 20, 21 and 22 are only for chambers with double blower motor connections for 240 VAC.

20. Remove the blower motor wire from TB1-3 and mark it #3 (this is a common wire to each motor).

21. Remove the blower motor wire from TB1-2 and mark it #2.

22. Remove the blower motor wire from TB1-4 and mark it #5.

23. Remove the thermocouple probe from the chamber and disconnect the wires from TB1.

24. Remove terminal block TB1 from the chamber.

25. Select the proper template for your model chamber (templates can be found at the back of these retrofit instructions). Cut out around the dotted line and place on the partition from which the terminal block was just removed. Drill on the cross marks with a #36 drill bit.

26. Install the auxiliary module with the terminal block toward the rear of the chamber. Use #6-3/8 sheet metal screws to secure the module to the panel.

27. Select one of the cables, #1667685-001 (the one with the larger 2-pin connector), and plug it into J10 on the Chamber AC board on the auxiliary module. Route the wire through to the partition and up to the area of the LN2 valve.

28. Install the new back panel onto the chamber. Be sure to replace any fiberglass previously removed.

29. Install the vent fan and finger guard onto the rear panel.

30. Plug cable #1667685-001 (the one with the small 2-pin connector) into J11 on the Chamber AC board on the auxiliary module. Connect the opposite end to the failsafe switch, S1, with the small wire nuts supplied.

31. Plug cable #1667685-002 (the one with the small 2-pin connector) into J15 on the Chamber AC board on the auxiliary module. Connect the opposite end to the vent fan on the rear of the chamber, using the small wire nuts supplied.

NOTE

Step 32 is for chambers with LCO2 cooling only.

32. Plug cable #1667685-001 (the one with the larger 2-pin connector) into J9 on the Chamber AC board on the auxiliary module. Before connecting the wires to the CO2 valve, change the coil in the LCO2 valve to the 24 VAC coil supplied in the kit (the small diameter coil). Now connect the wires from J9 to the CO2 valve L1.

NOTE

Step 33 is for chambers with LN2 cooling only.

33. For LN2 cooling change the coil on the LN2 valve (located on the rear of the chamber) to the 24 VAC coil (the larger diameter coil), and connect the wires with the small wire nuts, using the wires that were installed in step #27. Move the connector from J10 to J9.

NOTE

Step 34 is for chambers using both LN2 and LCO2 cooling.

34. After doing steps 32 and 33, and changing the coil in the LN2 valve, DO NOT move the connector from J10 to J9 as noted in step #33. Select cable #1667684-001 (the one with the 3-pin connector) and plug it into J8 on the Chamber AC board on the auxiliary module. Connect the wires to the dual switch as shown on the schematic. This switch should be removed from the old rear panel and installed in the new panel.

35. Connect the line cord going to the circuit breaker, to the line side (disregard the line filters; they are no longer needed).

36. Connect a white and black 12 gauge wire to the circuit breaker on the load side.

37. Connect the white wire to the terminal block, L1, and the black wire to L2.

    NOTE: To insert the wires into this terminal block, first strip back about 1/8 inch of insulation. Using a small bladed screw driver, insert it into the square behind where the wire goes and press in, then insert the wire in the round hole and remove the screw driver. If the wire is in properly, you should not be able to pull the wire out.

38. Take the wires that were removed from TB1 and numbered in the previous steps, and insert them into the proper numbers on the terminal block on the auxiliary module.

39. Take the horizontal jumpers #1400426 and insert them into the terminal block, jumpering together the proper pins as shown on the schematic for your chamber.

40. Install the 9010 controller into the chamber. Select the cable with the 10-pin connector and plug it between J7 on the Chamber AC board on the auxiliary module, and J10 on the temperature controller.

41. Select the cable with the 25-pin panel mount connector and mount it into the top cutout in the rear panel. Plug the other end into the connector on the controller marked RS-232.

42. Select the cable with the 24-pin panel mount connector and mount it into the lower cutout in the rear panel. Plug the other end into the connector on the controller marked GPIB.

43. Remove the old probe and insert the new probe, #1663594-101, into the empty socket. Connect the wires from it to the 9010 controller TB1; white to TB1-1 and red to TB1-2 and TB1-3.

2.1.2 Congratulations. If we did everything right, the chamber should now function properly. Read the accompanying 9010 controller manual to understand how to operate your new controller. If there are any questions regarding the installation and operation of your 9010 (after you have read the manuals), please call the Delta Design customer service department.

3.1 RETROFIT KIT PARTS LISTS AND DRAWINGS

There are five available retrofit kits for replacing the Type V Temperature Controller with a 9010 Temperature Controller, in older model Delta Design chambers. The following parts lists and drawings are to be used in referencing the instructions given in these conversion instructions. If there are any problems with missing parts, bad parts, or conversion instructions, please use the provided list when calling the Delta Design, Inc., Service Department for help or information. Have the Item Number, Part Number and Description available when making your calls, to facilitate a quick response time for parts, help and questions.

AVAILABLE RETROFIT KITS

PART NUMBER	DESCRIPTION
1667207-001	Chamber Retrofit Kit for 2300 Chamber to 9023
1667208-001	Chamber Retrofit Kit for 2800 Chamber to 9028
1667209-001	Chamber Retrofit Kit for 3900 Chamber to 9039
1667210-001	Chamber Retrofit Kit for 5900 Chamber to 9059
1667211-001	Chamber Retrofit Kit for 6400 Chamber to 9064

PART LIST DIFFERENCES

NOTE: THE PARTS LIST FOR EACH RETROFIT KIT IS EXACTLY THE SAME, EXCEPT FOR ITEM #1, WHICH IS THE REAR PANEL, AND ITEMS #7 AND #8 (OR #5 AND #6), WHICH ARE THE GPIB AND RS-232 CABLE ASSEMBLIES. THEREFORE, ONLY ONE PARTS LIST FOR A RETROFIT KIT WILL BE SUPPLIED. BY ORDERING A KIT WITH ONE OF THE ABOVE PART NUMBERS, YOU WILL GET THE KIT WHICH MATCHES THE CONFIGURATION YOU REQUIRE. THE ONLY PART NUMBER DIFFERENCE FOR ITEM #1 ON EACH PARTS LIST IS AS FOLLOWS:

ITEM	PART NUMBER	DESCRIPTION
1	2600033-002	Chamber Rear Panel for 9023
1	2635394-002	Chamber Rear Panel for 9028
1	2630571-002	Chamber Rear Panel for 9039
1	2635593-002	Chamber Rear Panel for 9059
1	2636323-002	Chamber Rear Panel for 9064

PART LIST DIFFERENCES (CONTINUED)

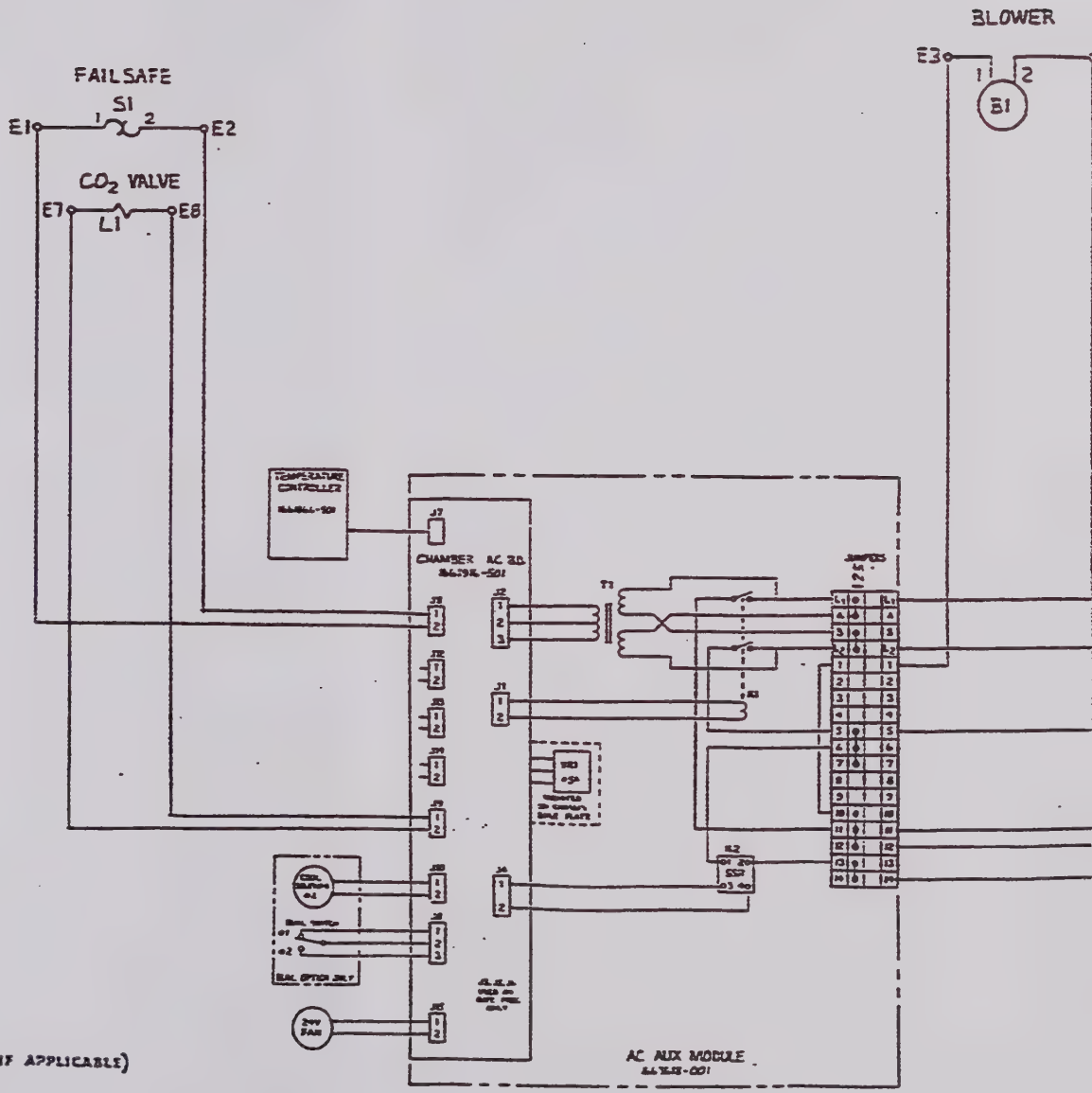
NOTE: TWO OTHER PARTS LIST ITEMS ARE DIFFERENT ON THE RETROFIT KITS TO THE 9023 AND 9028 CHAMBERS ONLY. ON ALL THE OTHER KITS, ITEMS 7 AND 8 CALL OUT 30 INCH CABLE ASSEMBLIES FOR THE GPIB AND RS-232. ON THE 9023 AND 9028 CONVERSIONS, ITEMS 7 AND 8 DO NOT EXIST; IN THEIR PLACE ARE THE FOLLOWING TWO ITEMS:

ITEM	PART NUMBER	DESCRIPTION
5	1664574-005	Cable Assembly, GPIB 20"
6	1664574-055	Cable Assembly, RS-232 20"

NOTE: OTHERWISE, ALL PARTS ARE THE SAME FOR EACH KIT.

LIST OF DRAWINGS AND PARTS LISTS

PART NUMBER	DESCRIPTION	PAGE
1667209-001	Chamber Retrofit Kit, 9039	10
1667200-000	Schematic, 125V, 2 Pole, 3 Wire Ground, Retrofit	12
1667201-000	Schematic, 240V, Single Blower w/LN2 & Dual Options, Retrofit	13
1667202-000	Schematic, 120V CO2 w/LN2 & Dual Options, Retrofit	14
1667203-000	Schematic, 240V, Dual Blower w/LN2 & Dual Options, Retrofit	15
1667204-000	Schematic, 208V w/CO2 & LN2 Options, 4 Wire, Retrofit	16
1667685-001,002	Cable Assy, Aux Mod Kit, 2 Pin	17
1667684-001	Cable Assy, Aux Mod Kit, 3 Pin	20
1663618-001	AC Auxiliary Module Assembly	22
1661916-501	PWA, Chamber AC Aux Mod	24
1661913-000	Schematic, Chamber AC	26
1663765-001	Terminal Block Assy, AC Aux Mod	27
1663613-001	Jumper Assembly, Interlock	29
1663614-001	Jumper Assembly, Dual Switch	31
1664574-XXX	Cable Assembly, GPIB/RS-232	33
1664861-001	Cable Assembly, Aux Mod	38
---	Pullout Template for 2300	
---	Pullout Template for 2850	
---	Pullout Template for 3900	
---	Pullout Template for 5900	
---	Pullout Template for 6400	



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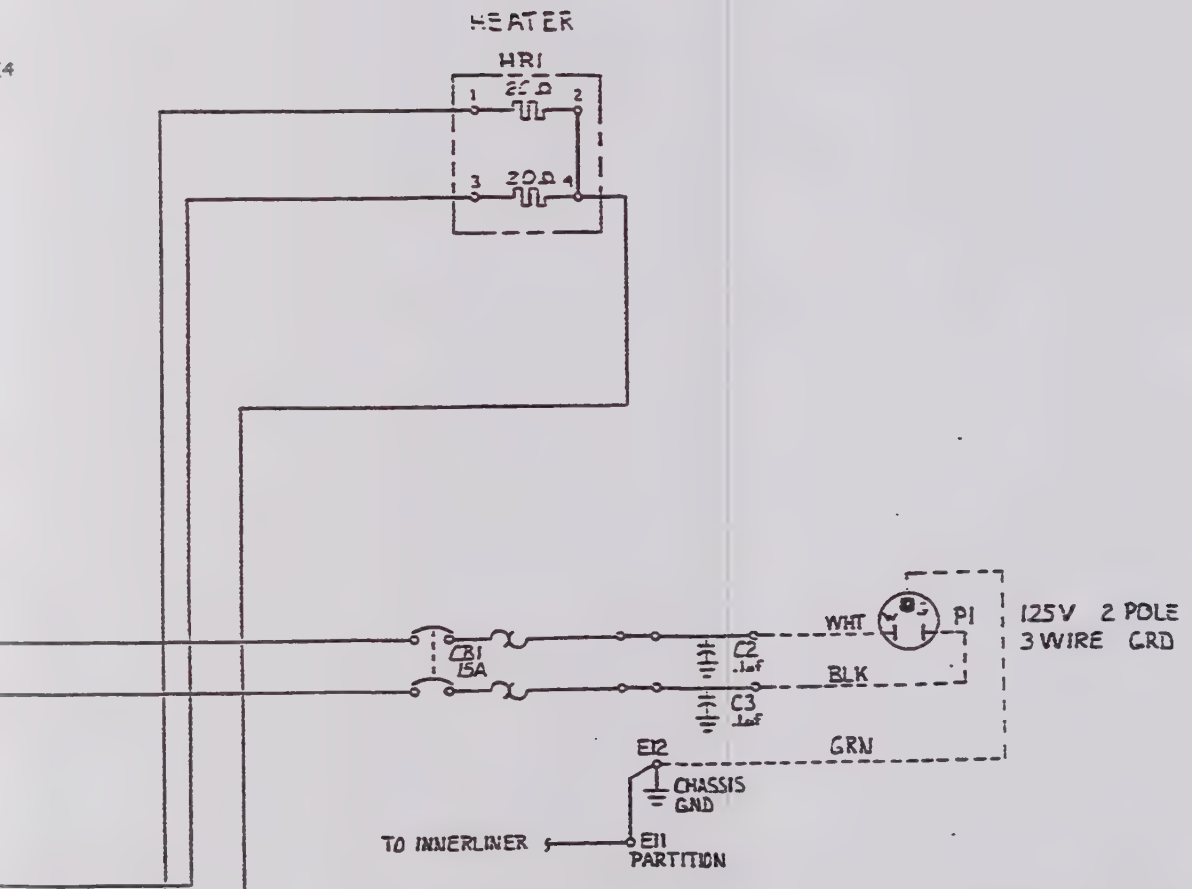

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ERN 7485

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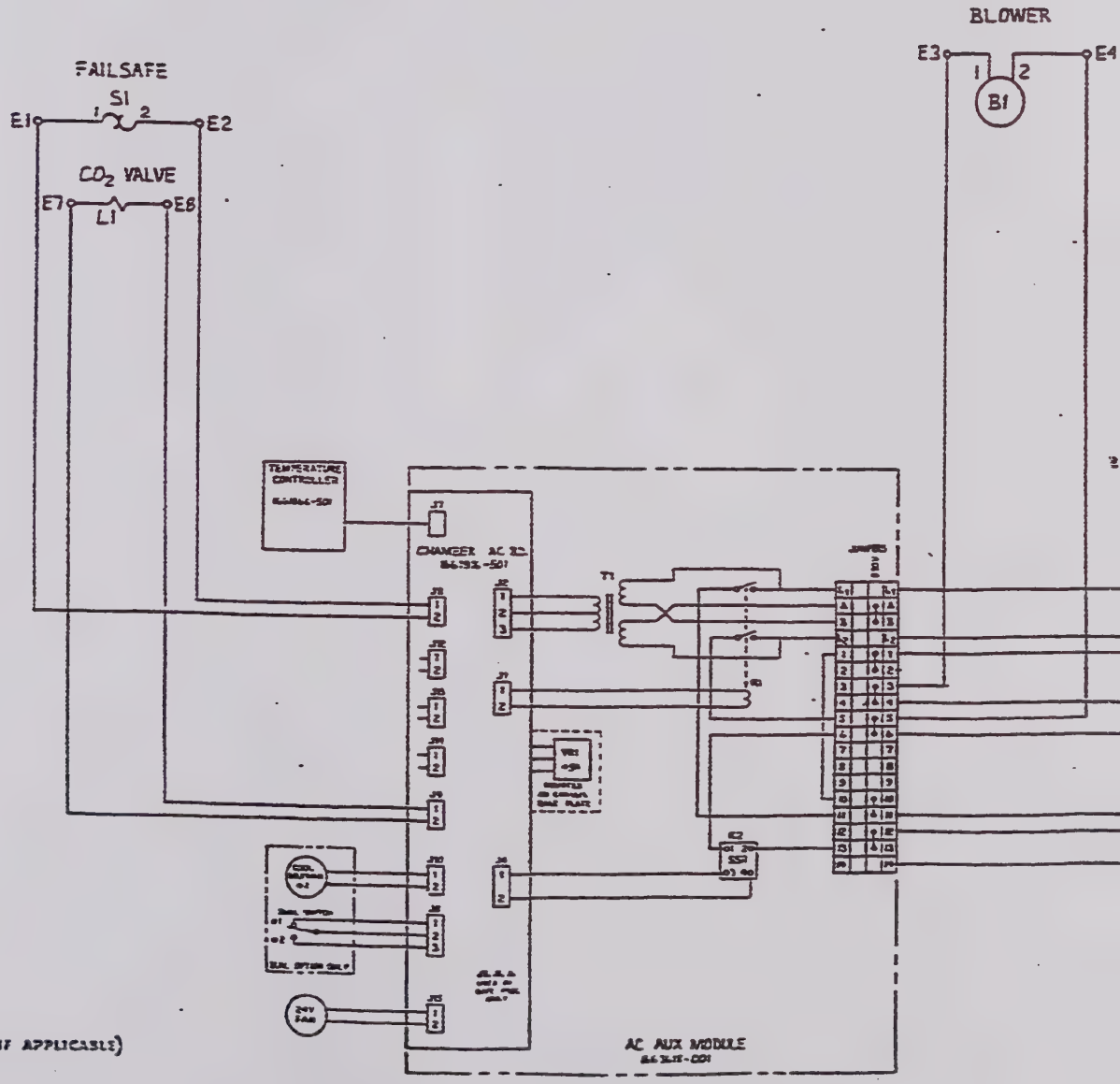
TITLE: SCHEM — 125V, 2 POLE 3 WIRE GND, RETROFIT

SIZE D | CODE IDENT | 1667200 | A

DO NOT SCALE DRAWING



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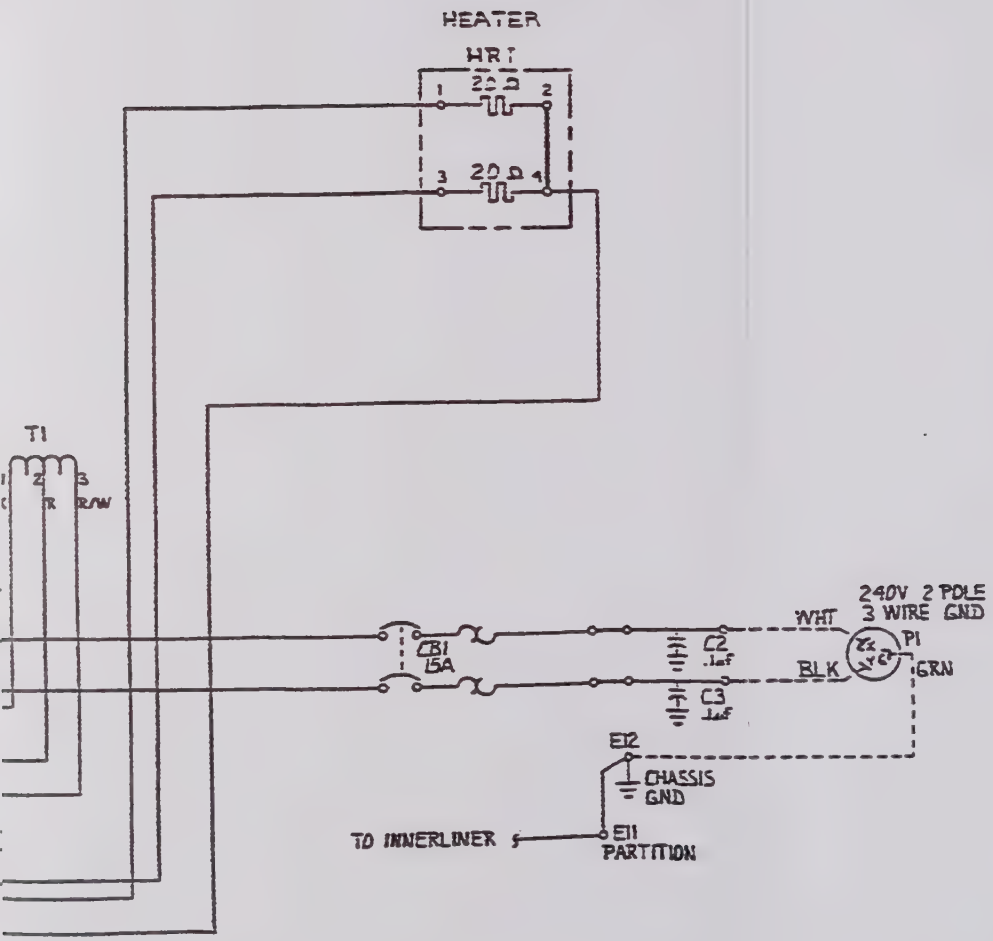

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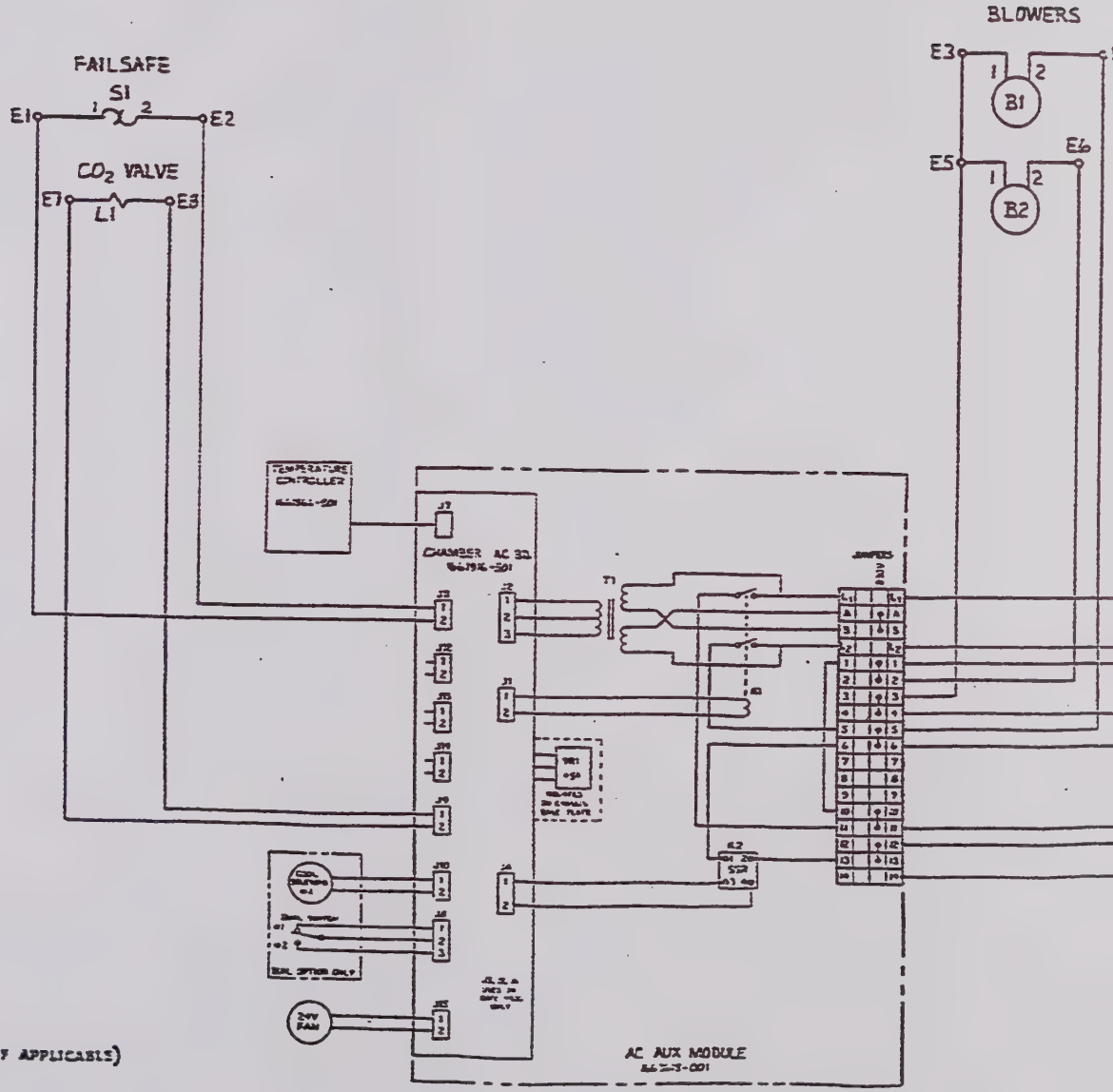

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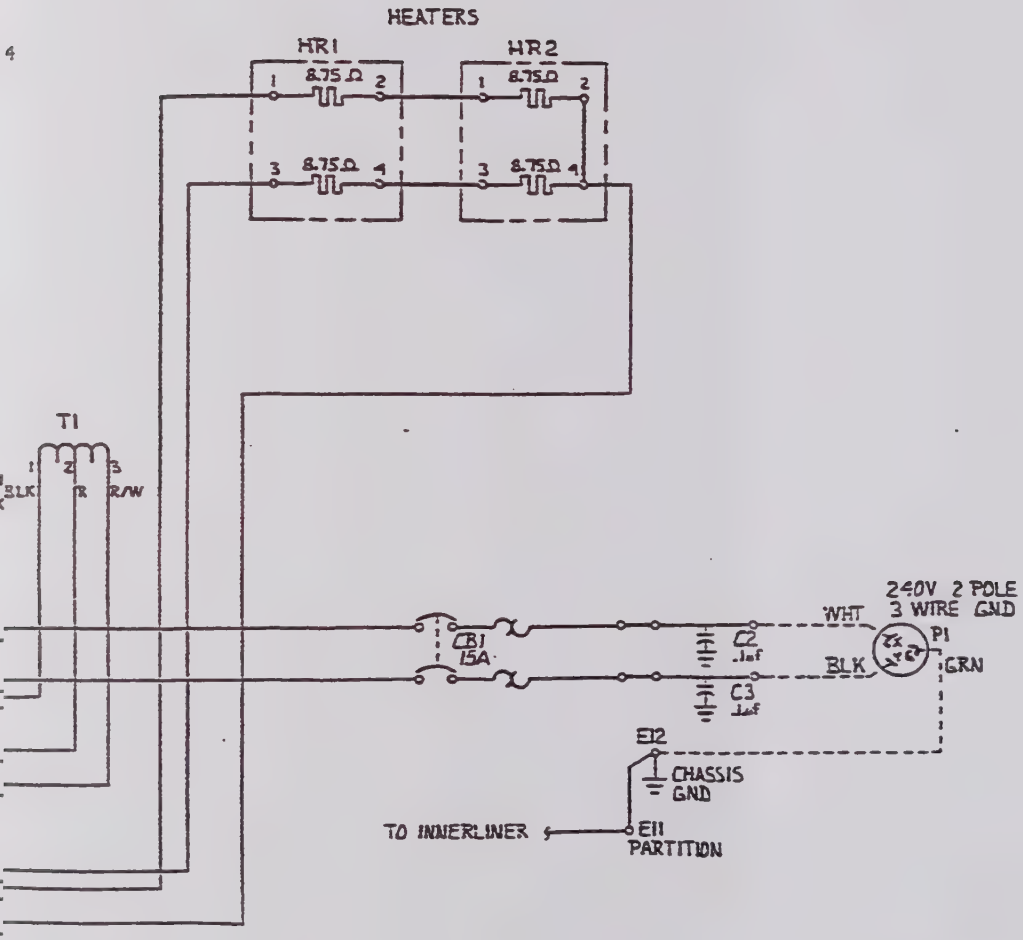

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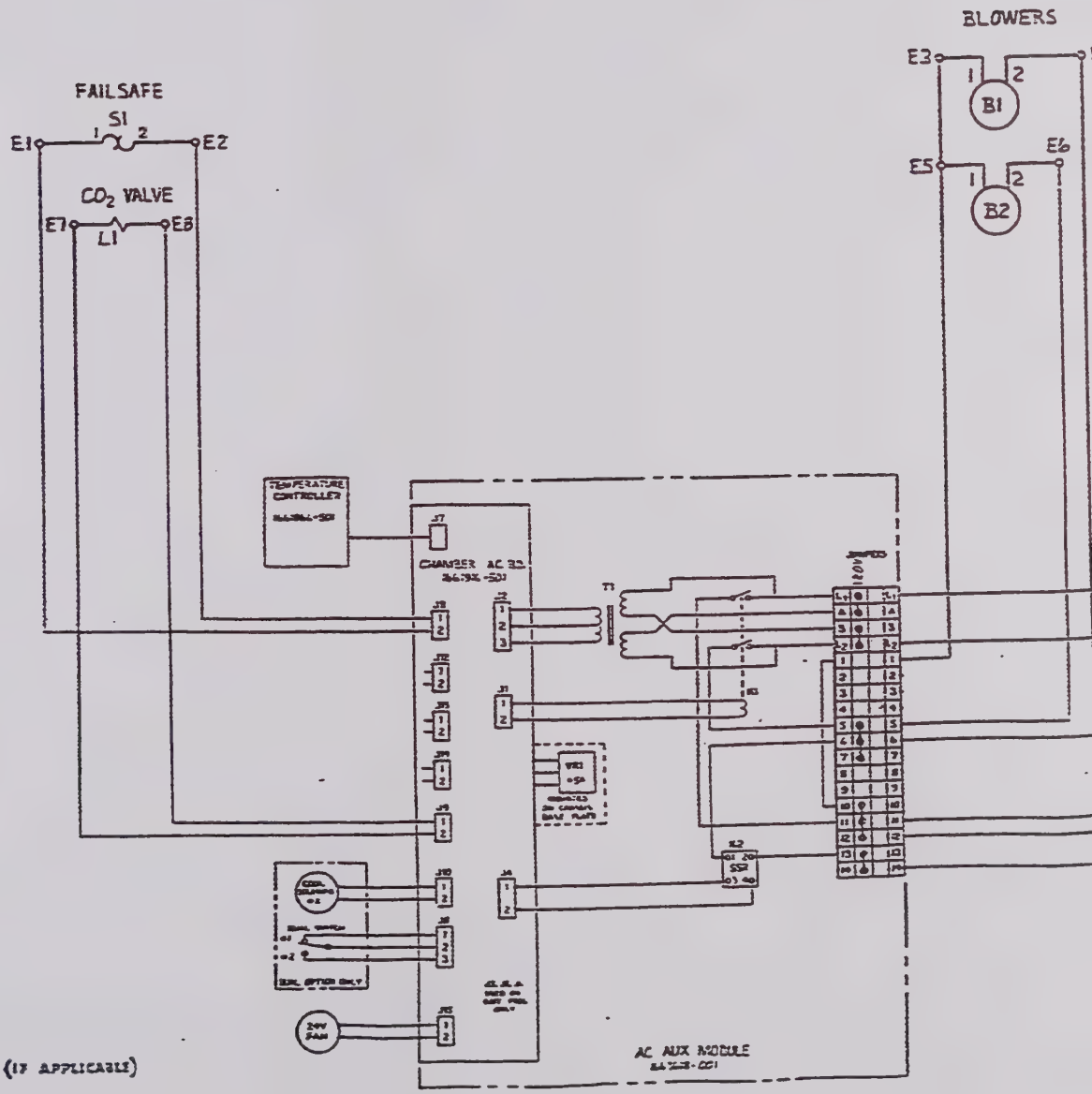

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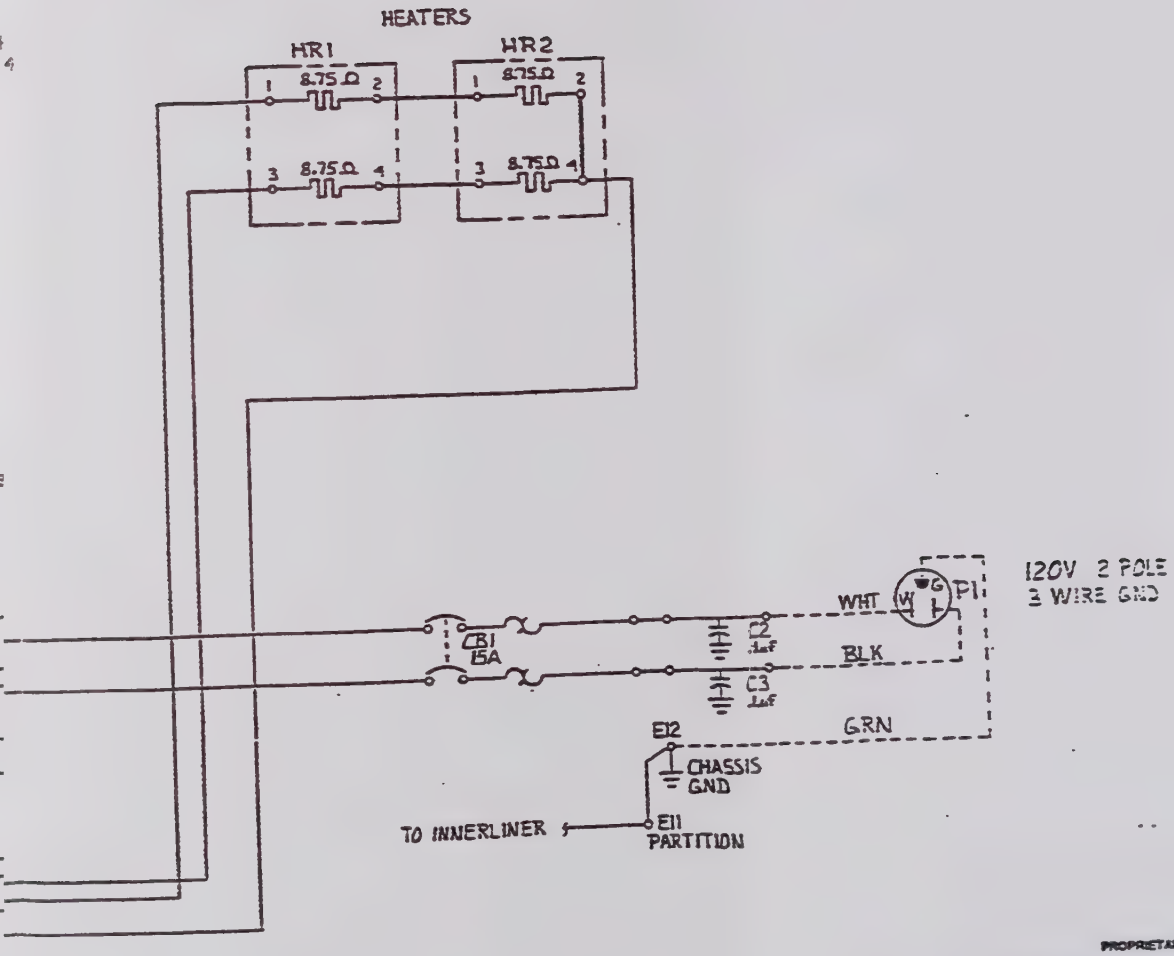

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ENGINEERING ACTIVITY: ERN 7485

DESIGN

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Delta Design

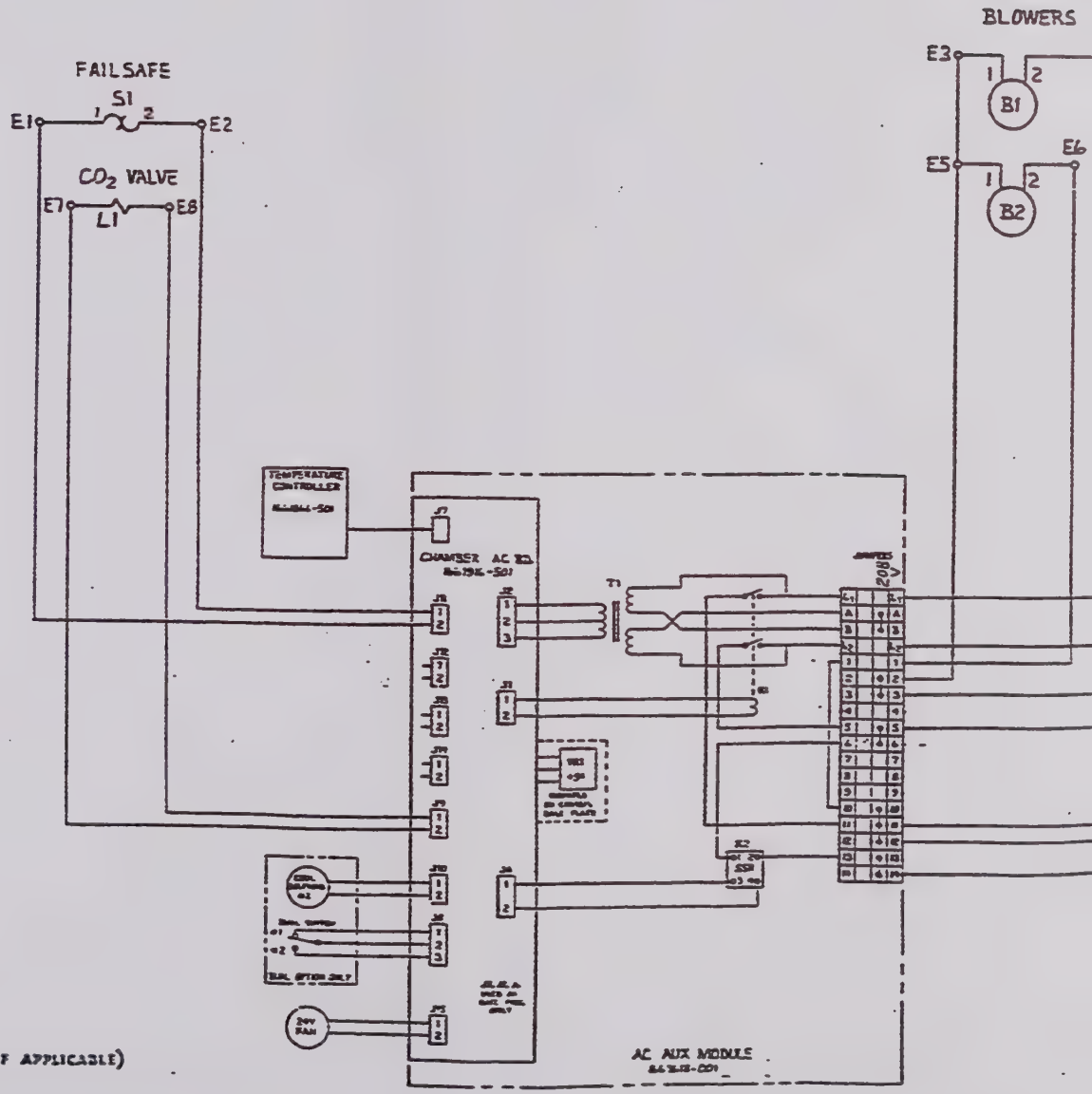
TITLE: SCHEM – 120V CO_2 W/ LN_2 & DUAL OPTIONS RETROFIT

SIZE: D | CODE IDENT | 1667202 | REV: A

MATERIAL

SERIAL NO.

DO NOT SCALE DWG



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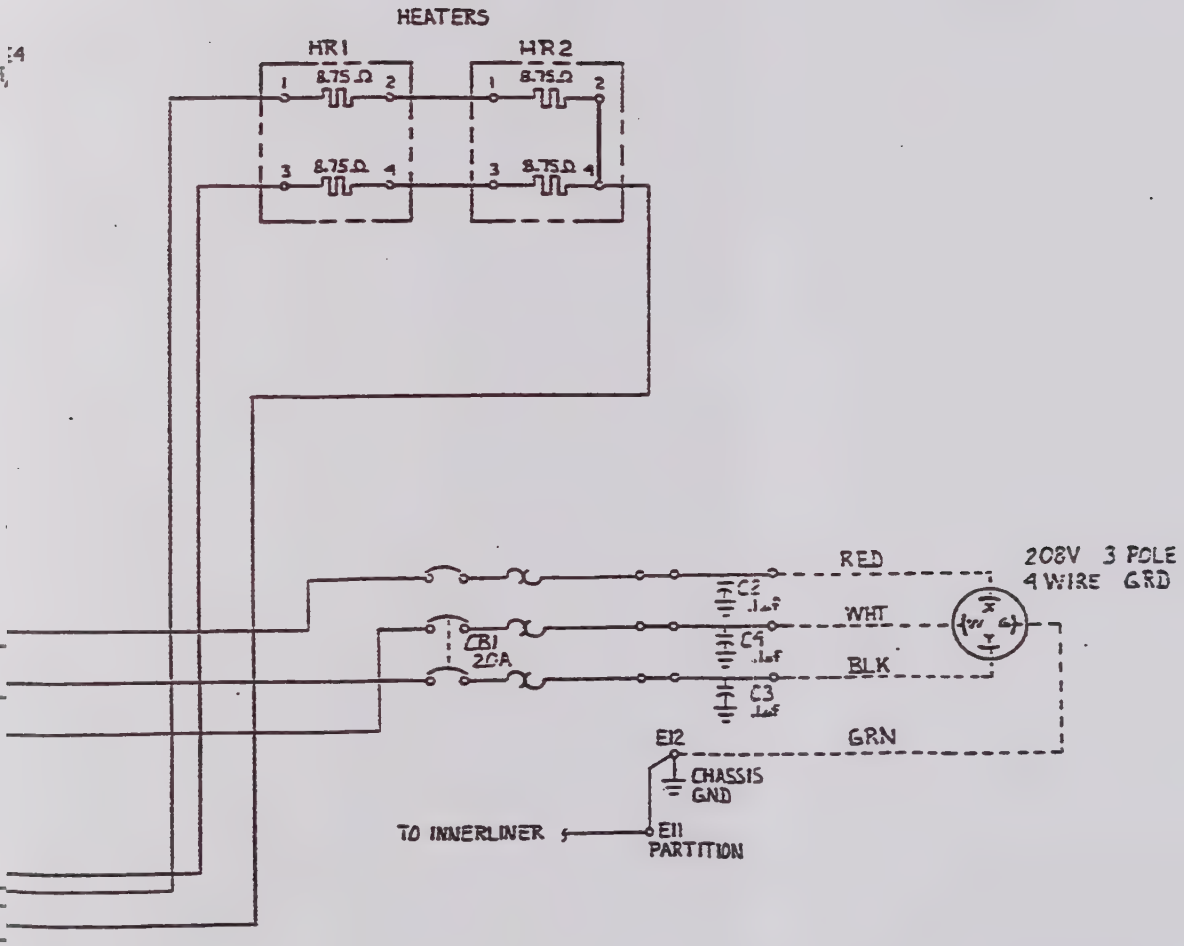

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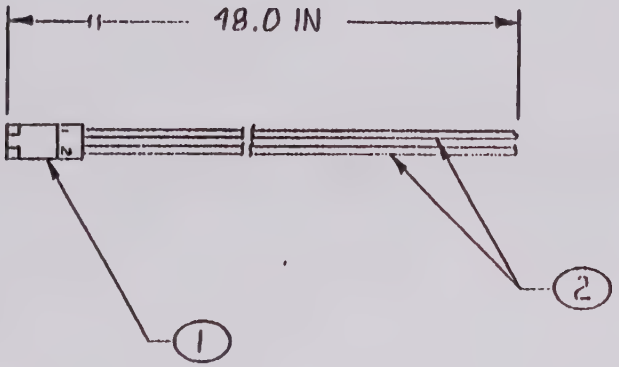

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DECIMALS .XX ± .03 .XXX ± .010
ANGLES 0°30'
INCH TOLERANCES
.010 ± .005 .100 ± .010
.010 ± .005 .200 ± .010

MATERIAL

FINISH

NOTES: UNLESS OTHERWISE SPECIFIED

ENGINEERING ACTIVITY: ERN 7485

DESIGN	
DRAFTED	T.SHEPARD 1/88
CHECKED	
APPROV	RP 2-96
RELEASE	

DO NOT SCALE DWG

Delta Design — 8770 KEARNY VILLA RD. SAN DIEGO, CA 92123-1111

TITLE: CABLE ASSY — AUX. MOD. KIT, 2 PIN

SIZE		REV.
B	1667685	A

SCALE NONE — SHEET 1 OF ___

15

DELTA DESIGN

PARTS LIST BY ITEM
ASSEMBLY: 1667685001
DESCRIPTION: CABLE ASSY - AUX.
REF/DES:

ITEM	PART NO.	DESCRIPTION	REF/DES	QTY
001	2000400	CONN RCPT 156 2 PIN 22AWG CABLE		1
002	1500365102	WIRE, 22 GA RED	48.0 IN	1

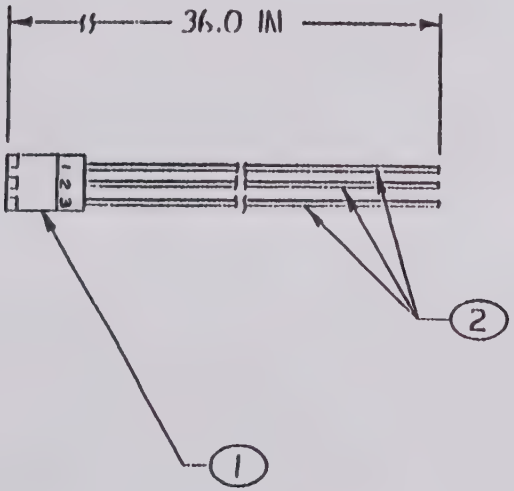
DELTA DESIGN

PARTS LIST BY ITEM
ASSEMBLY: 1687685002
DESCRIPTION: CABLE ASSY - AUX.
REF/DES:

ITEM	PART NO.	DESCRIPTION	REF/DES	QTY
001	2000405	CONN PLG 2P 22G .100		1
002	1500365102	WIRE,22 GA RED	48.0 IN. ;IN.	1

1667684

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPD
	A	ERN 7185 BS. 1-29-88		



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DASH	QTY	NEXT ASSY	USED ON
001			

APPLICATION

SERIAL NO. | DATE EFF | DWG REV

EFFECTIVITY

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON DECIMALS .XX ±.05 .XXX ±.010 ANGLES ±1°

HOLE TOLERANCES

MATERIAL

FINISH

ENGINEERING ACTIVITY ERN 7185

DESIGN	
DRAFTED	T.SHEPARD 1/88
CHECKED	
APPROV	RP 2-88
RELEASE	C. Hsi

DO NOT SCALE DWG

Delta Design

8778 KEARNY VILLA RD. SAN DIEGO, CA 92123-1111

TITLE: CABLE ASSY — AUX. MOD. KIT, 3 PIN

SIZE B | 1667684 | REV. F

SCALE NONE | SHEET 1 OF

NOTES: UNLESS OTHERWISE SPECIFIED

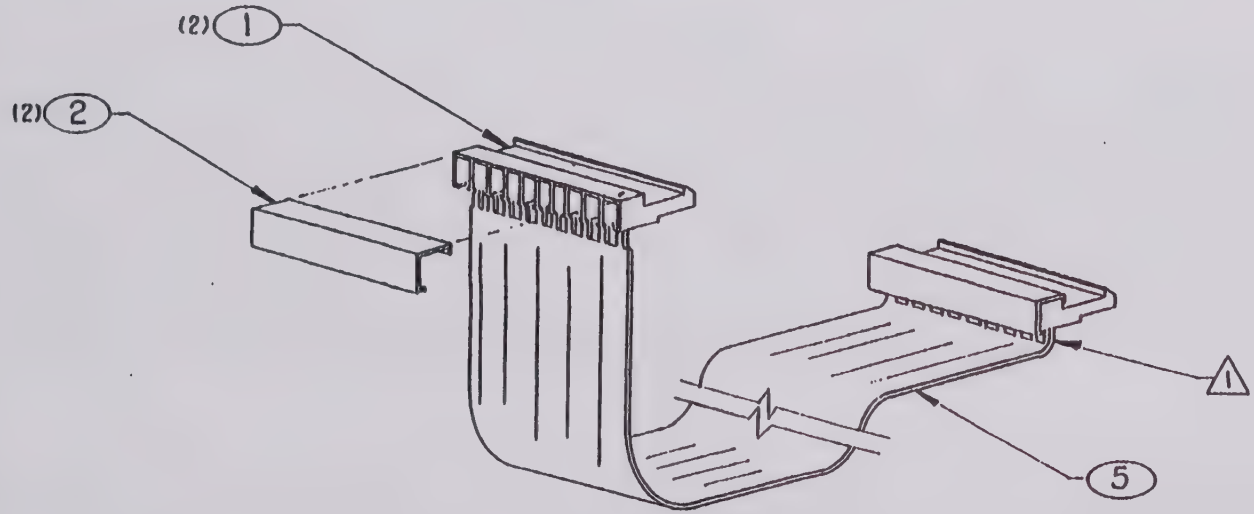
DELTA DESIGN

PARTS LIST BY ITEM
ASSEMBLY: 1667684001
DESCRIPTION: CABLE ASSY - AUX.
REF/DES:

ITEM	PART NO.	DESCRIPTION	REF/DES	QTY
001	2000435	CONNECTOR RECT LOCK-ING 3 PIN 18 AWG 156SF 045 SG		1
002	1500387103	WIRE, 18 GA ORANGE	36.0 IN	1

1664861

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPD
	A	ERN 7378	4/23/87	WCD



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⚠1 CUT CABLE ENDS IN MIDDLE OF NOTCHES

NOTES: UNLESS OTHERWISE SPECIFIED

DASH	QTY	NEXT ASSY	USED ON
001	/	MULTI	CH

APPLICATION

SERIAL NO. | DATE EFF | DWG REV

EFFECTIVITY

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON DECIMALS .XX ±.03 .XXX ±.010 ANGLES ±0°30'

HOLE TOLERANCES

MATERIAL

FINISH

ENGINEERING ACTIVITY ERN 7378		
DESIGN		
DRAFTED	E.SAMSON 3-87	
CHECKED		
APPROV	WCD	4/23/87
RELEASE	[signature]	4/23/87

DO NOT SCALE DWG

Delta Design — 6778 KEARNY VILLA RD. SAN DIEGO, CA 92123-1111

TITLE: CABLE ASSY- AUX MOD TO TEMP. CONT.

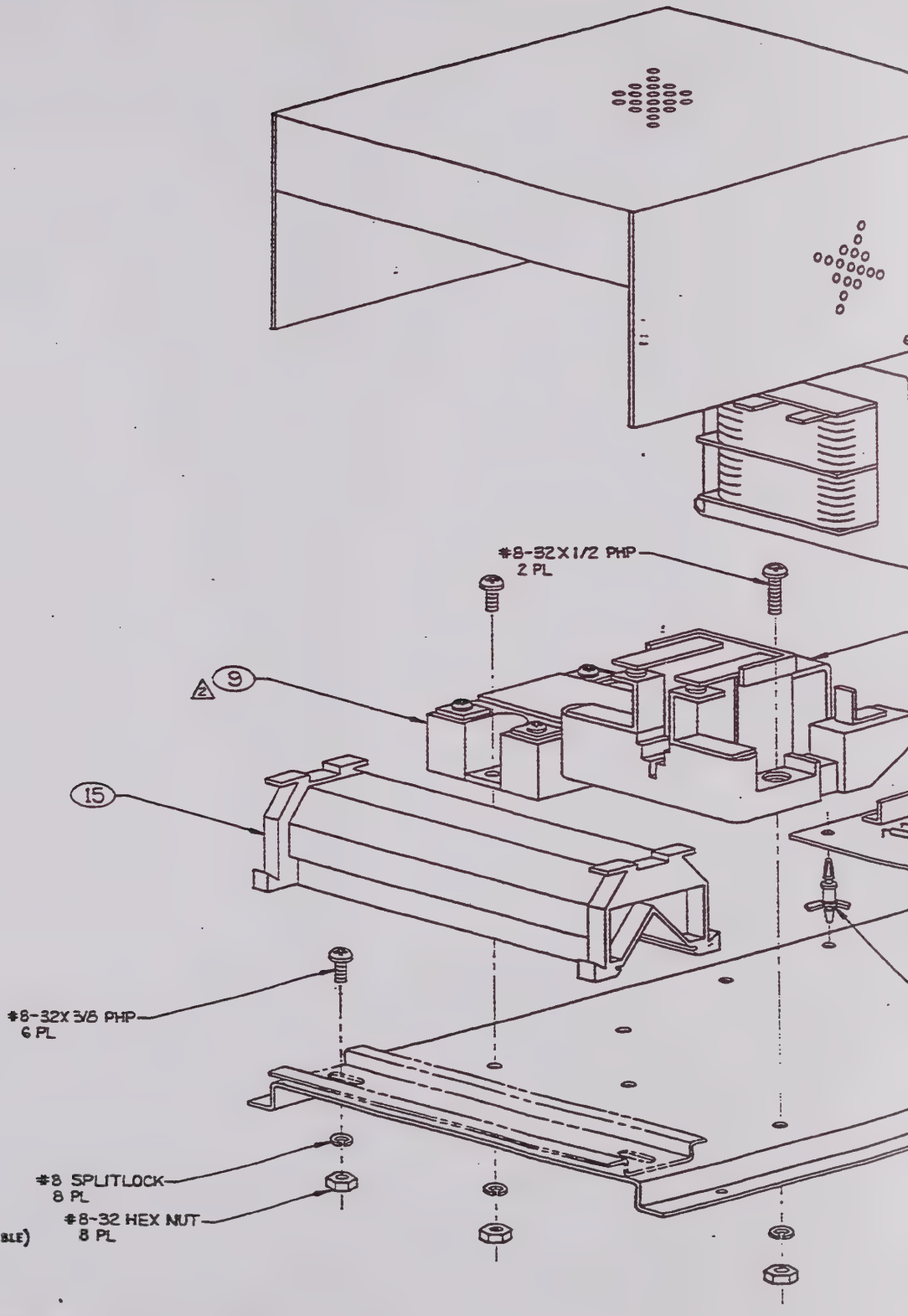
SIZE B | 1664861 | REV. A

SCALE 1/1 | SHEET 1 OF 1

20

ASSEMBLY: 1664861001
DESCRIPTION: CABLE ASSY-AUX MOD
REF/DES:

ITEM	PART NO.	DESCRIPTION	REF/DES	QTY
001	2000449	CONN RECT LOKNG 10 PIN 156 SP 22 AWG		2
002	2000456	COVER, STRAIN RELIEF 10 CKTS MTA-156		2
005	1664741101	CABLE ROUND COND FLT .156 CTR 10 CKT PRE-NOTCHED 22AWG		15



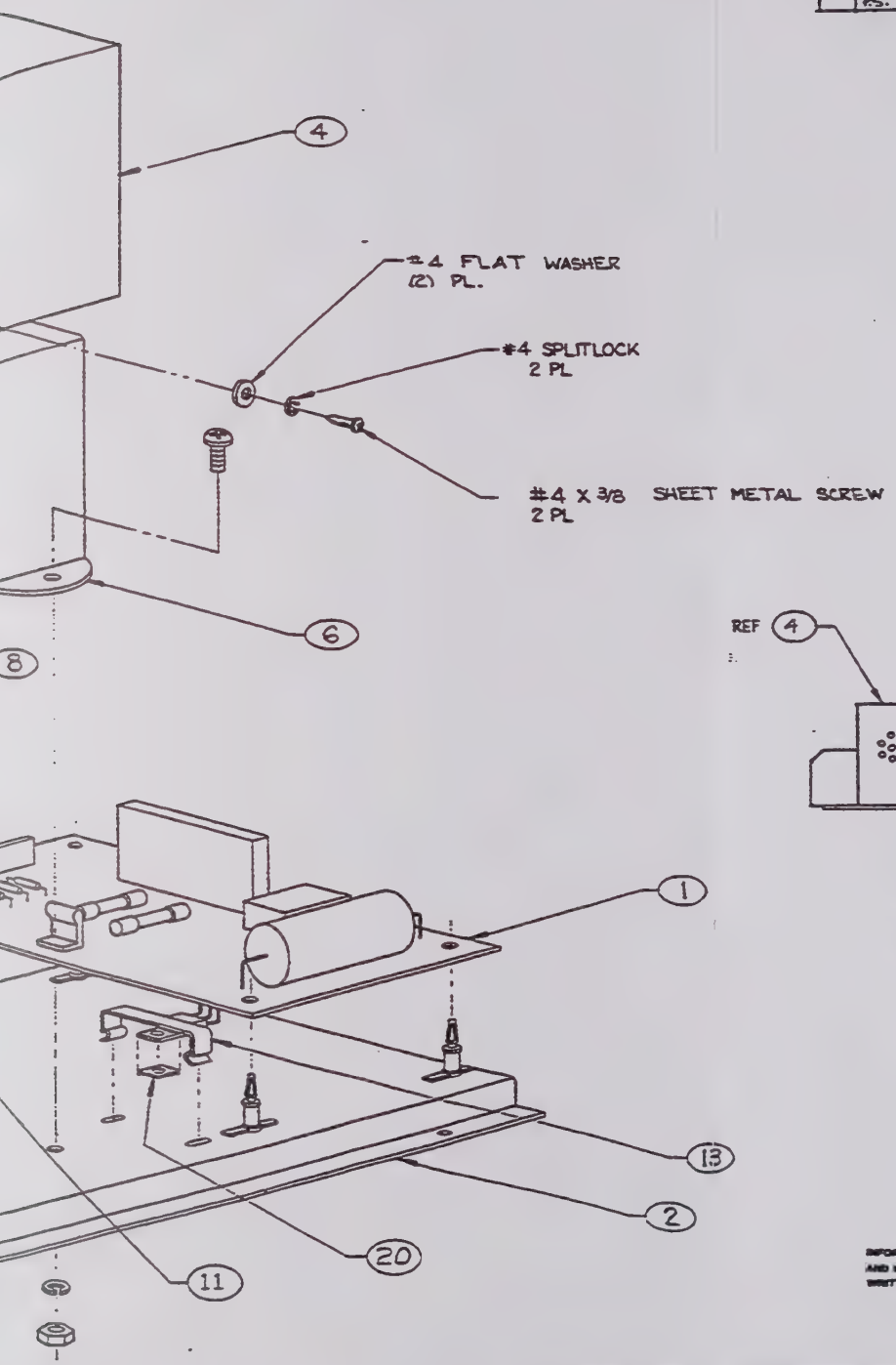
3 FINISH (IF APPLICABLE)

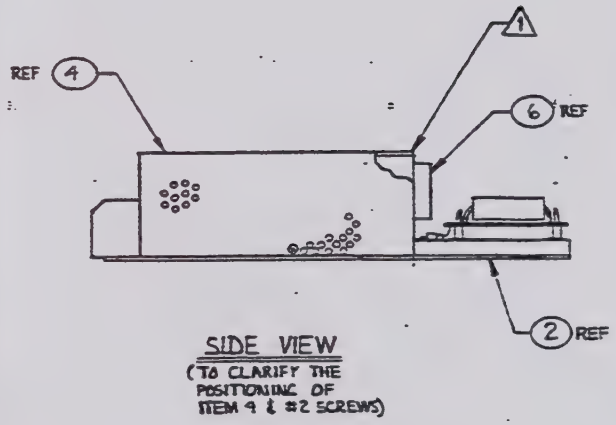
3 [redacted] APPLY THERMAL COMPOUND TO ITEM 9

1 FLUSH END OF ITEM #4 TO THE END OF ITEM #6 AS SHOWN.

NOTES: UNLESS OTHERWISE SPECIFIED

ZONE	LTR	DESCRIPTION	DATE	APPD
	A	RELEASED ECN 7363 EFF. 12-3-86	11/7/86	WCD
	B	#4X3/8 SMS WAS #8-40 X 1/4 PHP. DELETED NOTE 1. ADDED #4 FLAT WASHER. EFFECTIVE NEXT RUN. PSHOGREN 1-13-87	1/14/87	C/B
	C	ADDED NOTE 2< ITEM 20 EFF NEXT RUN PS. 10-23-87	11/5/87	C/B





SIDE VIEW
(TO CLARIFY THE POSITIONING OF ITEM 4 & #2 SCREWS)

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DASH QTY	NEXT ASSY	USED ON	SERIAL NO.	DATE EFF	DWG REV
001 1					
APPLICATION			EFFECTIVITY		

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS .XX ± .03 .XXX ± .010
ANGLES 0° 30'
HOLE TOLERANCES

MATERIAL
FINISH

ENGINEERING ACTIVITY
ECN 7363

DESIGN	
DRAFTED	E. SAMSON
CHECKED	
APPROV	11/7/86
RELEASE	12/1/86

DO NOT SCALE DWG

Delta Design
A Cohu Company
5775 KEARNY VILLA RD. SAN DIEGO, CA 92123-1111

TITLE:
AC AUX MODULE ASSY

SIZE	CODE IDENT		REV
D		1663618	C
SCALE 1/1		22	SHEET 1 OF 1

DELTA DESIGN

PARTS LIST BY ITEM

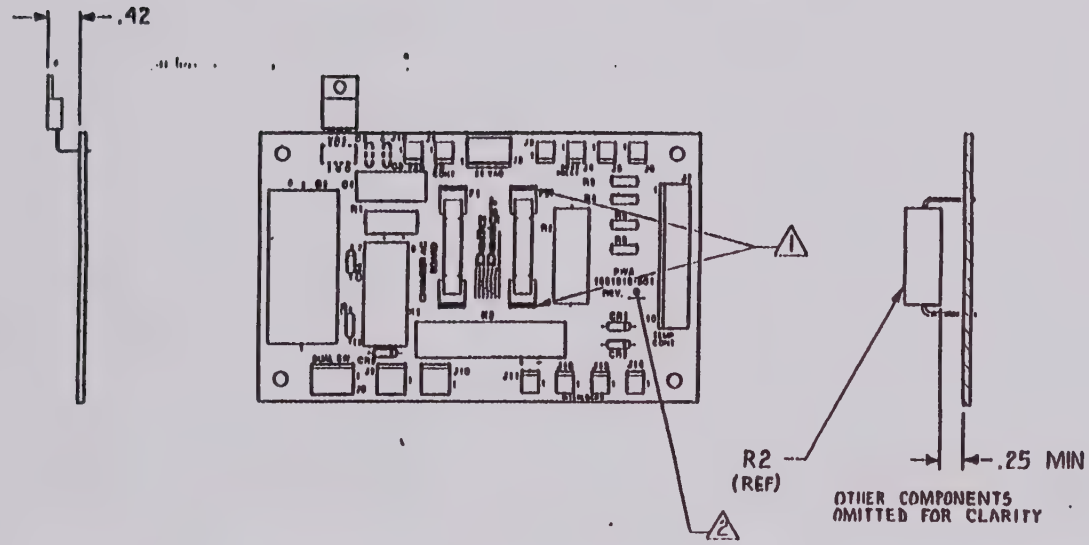
ASSEMBLY 1663618001

DESCRIPTION. AC AUX MODULE ASSY

REF/DES

ITEM	PART NO.	DESCRIPTION	REF/DES	QTY
001	1661916501	PWA, AUX. MODULE		1
002	1662214101	CHASSIS, AC AUX. MOD		1
003	1663783000	WIRING DIAGRAM-AC AUX MODULE		REF
004	1663607101	COVER, PERFORATED AUX. MODULE		1
005	1500441101	LABEL, 2.25" x 2.25" DANGER-HIGH VOLTAGE		1
006	1663612101	TRANSFORMER POWER 24V 4A	T1	1
008	1400384	RELAY POWER DPST-NO 24VAC 10A	K1	1
009	1400194	RELAY, SOLID STATE 25 AMP, 48-280 VOLT	K2	1
011	1501865	SUPPORT PCB NYLON LOCK-3/8 SPACE		4
013	1400316	CLIP SPRING IC MTG		1
015	1663765001	TERM BLK ASSY, AC AUX		1
019	1500061	LUG, RING, YELLOW 10-12 AWG WIRE, #10		6
020	2400135	PAD THERMAL INSUL TO-220		1
021	1500071	LUG, RING, BLUE, INSULA 16-14 AWG, #10 STUD		2
022	1500055	LUG, SPADE, #6 RED		2
023	2000405	CONN PLG 2P 22G 100	P1, P4	2
024	2000435	CONNECTOR RECT LOCA-ING 3 PIN 12 AWG 156SP 045 SG	P2	1
025	1663613001	JUMPER ASSY, INTERLOC		1
026	1663614001	JUMPER ASSY DUAL SW		1

ZONE	LTR	DESCRIPTION	DATE	APPD
	B	REDESIGNED PWB T.S.		
	C	ADDED J15, C5 & CR4 T.S. 10-16-86		
	D	ERN 7363	2/26/87	[illegible]
	E	ECN 7425	7-8-87	[illegible]



⚠2 MARK CURRENT REV LEVEL, WHERE SHOWN, USING BLACK INDELIBLE INK.

⚠ INSTALL FUSE HOLDERS AS SHOWN.

NOTES: UNLESS OTHERWISE SPECIFIED

DASH	QTY	NEXT ASSY	USED ON	SERIAL NO.	DATE EFF	DWG REV
S01			MLX1			
APPLICATION				EFFECTIVITY		

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS .XX ±.05 .XXX ±.010
ANGLES 0°30'
HOLE TOLERANCES
.010 +.001 -.000 .000 +.003 -.001
.010 +.001 -.000 .000 +.003 -.001
MATERIAL ⚠1
⚠1

ENGINEERING ACTIVITY		
ERN 7363		
DESIGN		
DRAFTED	T.SHEPARD 4-21-86	
CHECKED		
APPROV	[illegible]	12/1/86
RELEASE	S.W.	12-8-86
DO NOT SCALE DWG		

DELTA DESIGN INC.
A SUBSIDIARY OF CONU INC.
SAN DIEGO, CA. 92138

TITLE: PWA – CHAMBER AC

SIZE	CODE IDENT		REV
C		1661916	E

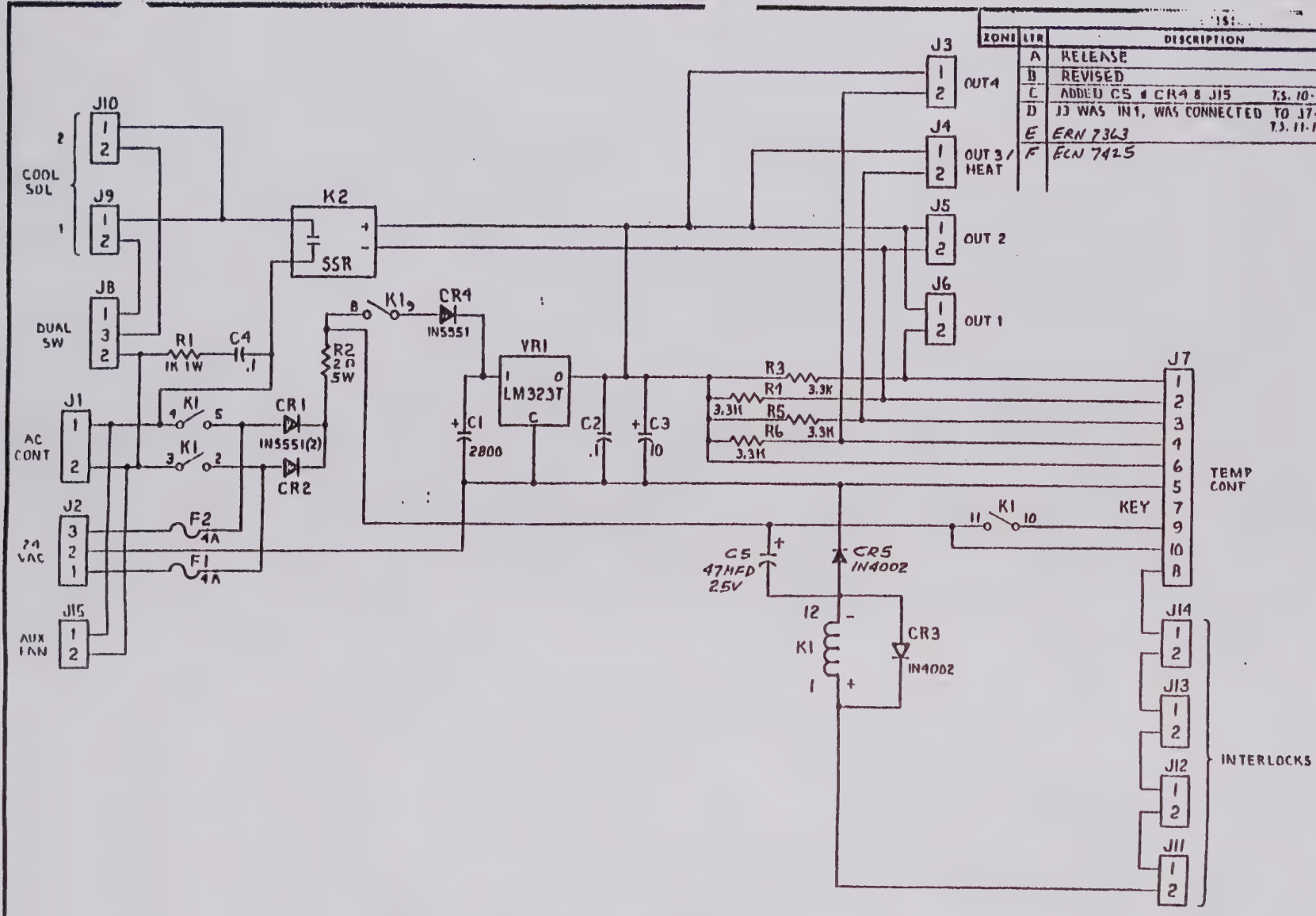
SCALE 1/1 SHEET 1 OF 1

24

DELTA DESIGN

PARTS LIST BY ITEM
ASSEMBLY 1661916501
DESCRIPTION PWA, AUX. MODULE
REF/DES

ITEM	PART NO.	DESCRIPTION	REF/DES	QTY
001	1661915401	PWB AC AUX MODULE		1
003	1661913000	SCHEMATIC AC AUX MOD		REF
005	1000586	IC POS VOLT REG 5V 3A LM323T	VR1	1
006	0303324500	RES, 3.3K, 1/4W, 5%	R3-R6	4
007	0301021500	RES. 1K, 1W, 5%	R1	1
008	0400128	RES WIREWOUND 2 OHM 5W 5%	R2	1
009	0800053	CAP ALUM ELECTRO 2800MFD 25WVDC-10+75%	C1	1
010	0800022	CAP CERAMIC .1MFD 50V 20% RADIAL LEAD	C2	1
011	0701000026	CAP TANTALUM 10MFD 25V	C3	1
012	0800052	CAP POLYESTER 0.1MFD 200WVDC 10%	C4	1
013	0800054	CAP ELECTROLYTIC 47 MFD 25WVDC RADIAL LEAD	C5	1
014	1105551	DIODE, 1N5551	CR1, CR2, CR4	3
015	1104002	DIODE, 1N4002	CR3, CR5	2
017	1400442	RELAY 4 FORMA 12VDC 200mW 4A250VAC 3A30VDC PC MTG	K1	1
018	1400443	RELAY SOLID STATE 24VAC 3A CONTROL 3-32VDC PC MTG	K2	1
020	1400088	FUSE, 314004, SLO-BLO	F1, F2	2
021	1400385	FUSE CLIP PC MTG 1/4" DIA FUSE	XF1, XF2	4
024	2000398	CONN HDR STR 100 PCB 2P	J1-J6, J11-J14	10
025	2000418	CONN HDR STR 156 SP 2 POS 045SQ PIN LOCK	J9, J10	2
026	2000424	CONN HDR STR 156SP 3POS 045SQ PIN LOCK	J8	1
027	2000427	CONN HDR STR 156 SP PCB MTG 10 POS 045SQ	J7	1



ZONE	LTR	DESCRIPTION	DATE	APPD
	A	RELEASE		
	B	REVISED		
	C	ADDED C5 & CR4 & J15 T.S. 10-9-86		
	D	J3 WAS IN1, WAS CONNECTED TO J7-5 T.S. 11-11-86	12/1/86	W.S.
	E	ERN 7363		
	F	ECN 7425	7.6.87	

2. ALL CAPS IN MICROFARADS.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON DECIMALS .XX ±.03 .XXX ±.010 ANGLES ±30' HOLE TOLERANCES

ENGINEERING ACTIVITY: ERN 7363

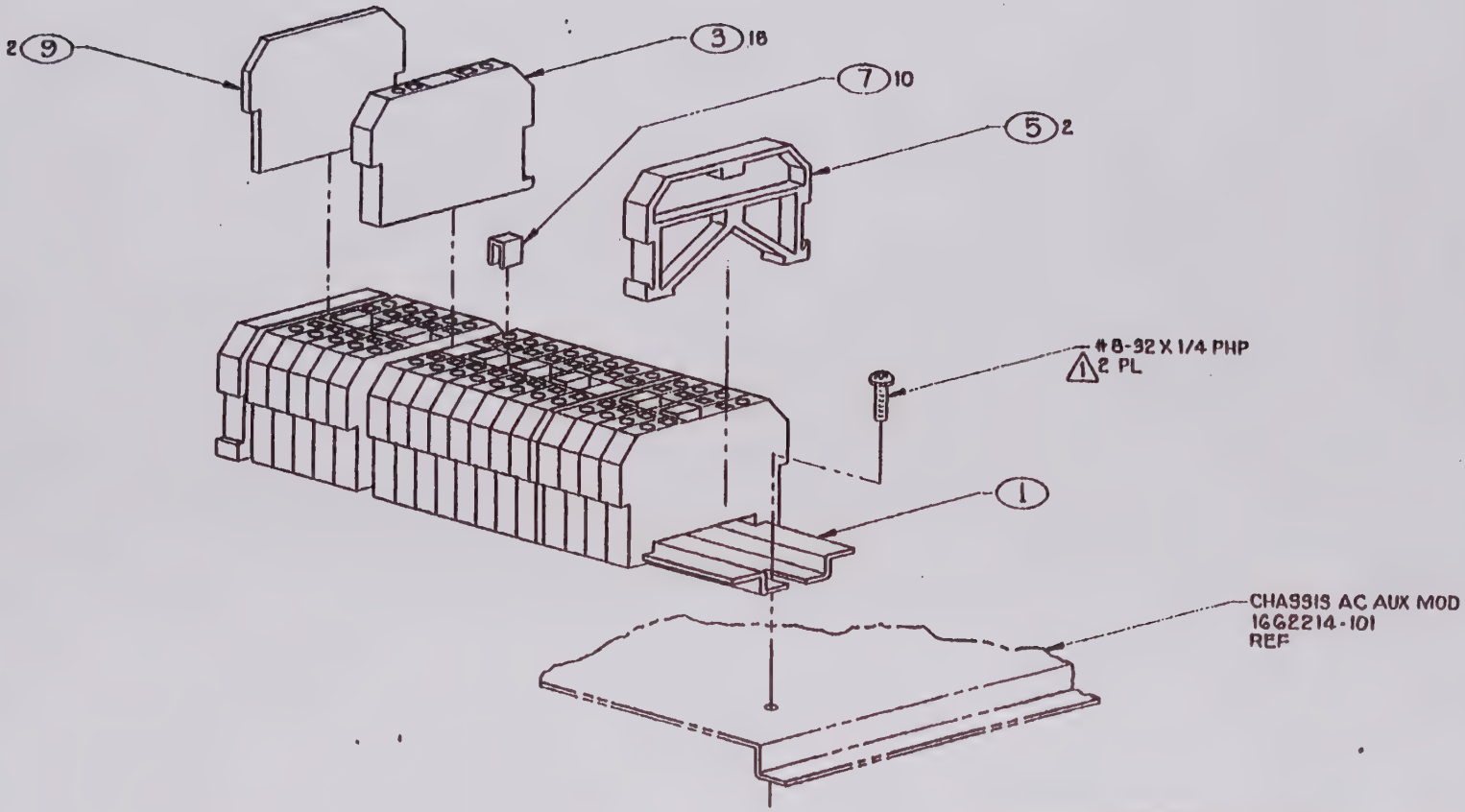
DESIGN
DRAFTED T. SHEPARD 4-16-86
CHECKED
APPROV W.S. 12/11/86

DELTA DESIGN INC.
A SUBSIDIARY OF CONU INC.
SAN DIEGO, CA. 92123

TITLE: SCHEMATIC DIAGRAM — CHAMBER AC

SIZE C | CODE IDENT | REV

ZONE	LTR	DESCRIPTION	DATE	APPD
	A	RELEASED (ERN 7363) T.S.	4/17/86	



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⚠ [illegible]

⚠ [illegible]

INSTALL BEFORE ASSEMBLING

NOTES: UNLESS OTHERWISE SPECIFIED

DASH	QTY	NEXT ASSY	USED ON
001	1	1663618	

APPLICATION

SERIAL NO. | DATE EFF | DWG REV

EFFECTIVITY

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS .XX ±.03 .XXX ±.010
ANGLES 0°30'
HOLE TOLERANCES

MATERIAL ⚠

FINISH ⚠

ENGINEERING ACTIVITY: ERN 7363

DESIGN		
DRAFTED	E. SAMSON	
CHECKED		
APPROV	[illegible]	4/17/86
RELEASE	[illegible]	4/17/86

DO NOT SCALE DWG

Delta Design
6775 KEARNY VILLA RD.
SAN DIEGO, CA
92123-1111

TITLE: TERMINAL BLOCK ASSY, AC AUX MOD

SIZE	CODE IDENT		REV
C		1663765	A

SCALE 1/1 SHEET 1 OF ___

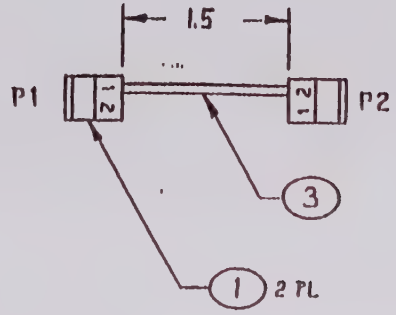
DELTA DESIGN

PARTS LIST BY ITEM
ASSEMBLY 1663765001
DESCRIPTION TERM BLK ASSY, AC AUX
REF/DES

ITEM	PART NO.	DESCRIPTION	REF/DES	QTY
001	1662704602	RAIL, 5.00"		1
003	1400427	TERMINAL BLOCK 600V 20A AWG 24-12		18
005	1400434	END PLATE TERM BLK.		2
007	1400426	JUMPER HORIZONTAL INSULATED 26A		10
009	1400425	END STOP-TERMINAL BLOCK		2

16	63613

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPD
	A	RELEASED (ERN 7363) T.S. 12-2-86	12/17/86	WKS



DD1	1	1663618	MULTI					
DASH	QTY	NEXT ASSY	USED ON	SERIAL NO.	DATE EFF	DWG REV	MATERIAL	
APPLICATION				EFFECTIVITY			FINISH	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS .XX ±.03 .XXX ±.010
ANGLES ±1°
HOLE TOLERANCES

ENGINEERING ACTIVITY	
	ERN 7363
DESIGN	
DRAFTED	T. SHEPARD 12-2-86
CHECKED	
APPROV	WCD 12/17/86
RELEASE	12-86
DO NOT SCALE DWG	

DELTA DESIGN • INC.
A SUBSIDIARY OF CONU INC.
SAN DIEGO, CA. 92123

TITLE: INTERLOCK JUMPER ASSY

SIZE			REV.
B		1663613	A
SCALE NONE			SHEET 1 OF 1

NOTES: UNLESS OTHERWISE SPECIFIED

PARTS LIST BY ITEM
ASSEMBLY 16e3613001
DESCRIPTION JUMPER ASSY, INTERLOC
REF.DES

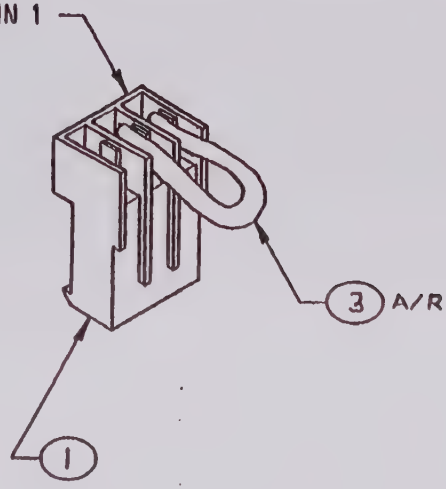
ITEM	PART NO.	DESCRIPTION	REF/DES	QTY
001	2000405	CONN PLG 2P 22G .100	P1,P2	2
003	1500365109	WIRE, 22 GA WHITE		0

EASY FILE CORP IRVINE CA MADE FROM RECYCLED PAPER

FC 63614	

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPD
	A	RELEASED (ERN 7363) T.S. 12-2-86	12/17/86	

P1
1
2
3



								UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON DECIMALS .XX ±.05 .XXX ±.010 ANGLES ±0° HOLE TOLERANCES	ENGINEERING ACTIVITY ERN 7363
									DESIGN
									DRAFTED T.SHEPARD 12-2-86
									CHECKED
001	1	1663618	MULTI						APPROV [illegible] 12/17/86
DASH	QTY	NEXT ASSY	USED ON	SERIAL NO.	DATE OFF	DWG REV	MATERIAL		RELEASE [illegible] 12-86
APPLICATION				EFFECTIVITY			FINISH		DO NOT SCALE DWG

DELTA DESIGN • INC.
A SUBSIDIARY OF CONV INC.
SAN DIEGO, CA. 92123

TITLE: DUAL SWITCH JUMPER ASSY

SIZE B | 1663614 | REV. A

SCALE NONE | SHEET 1 OF 1

NOTES: UNLESS OTHERWISE SPECIFIED

31

DELTA DESIGN

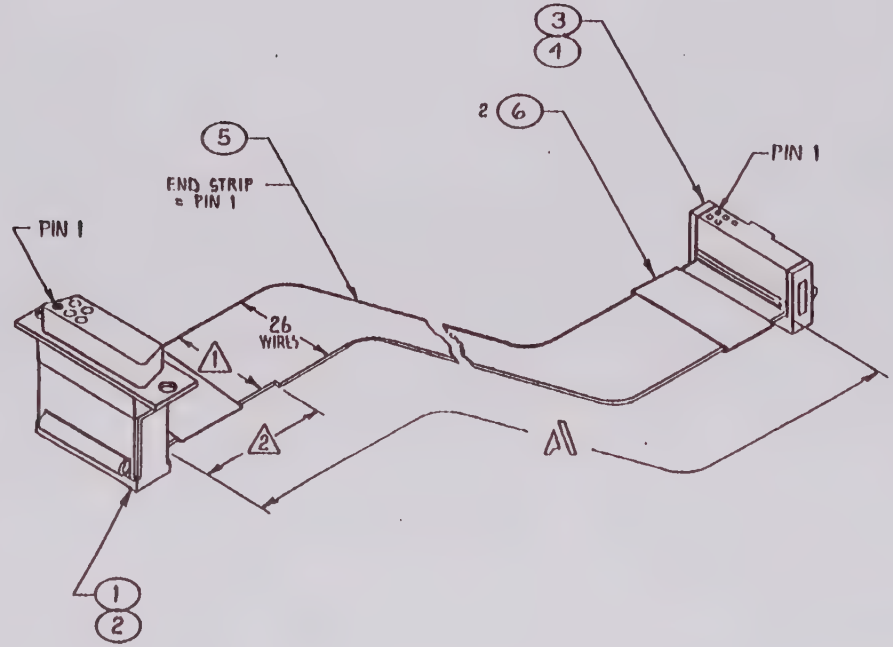
PARTS LIST BY ITEM
ASSEMBLY 1663614001
DESCRIPTION JUMPER ASSY DUAL SW
REF/DES

ITEM	PART NO.	DESCRIPTION	REF/DES	QTY
001	2000435	CONNECTOR RECT LOCK-ING 3 PIN 18 AWG 156SP 04S SG	P1	1
003	1500387103	WIRE, 18 GA ORANGE		0

DASH NO.	A (IN)
001	12
002	14
003	16
010	30
020	50
030	70
040	90
050	110
051	12
052	14
053	16
060	30
070	50
080	70
090	90
095	100

GPIB CONN

RS-232C CONN



REVISIONS			
ZONE	LTR	DESCRIPTION	DATE
	A	ERN 7378	4/23/87

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⚠ WIRE(S) TO BE CUT 1.5 INCHES FROM END OF CABLE.

⚠ GPIB USES 24 WIRES AND RS-232C USES 25 WIRES.

NOTES: UNLESS OTHERWISE SPECIFIED

DASH	QTY	NEXT ASSY	USED ON
		MULTI	

APPLICATION

SERIAL NO. | DATE EFF | DWG REV

EFFECTIVITY

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS .XX ±.03 .XXX ±.010
ANGLES 0°30'
HOLE TOLERANCES

MATERIAL ⚠

FINISH ⚠

DO NOT SCALE DWG

ENGINEERING ACTIVITY: ERN 7378

DESIGN		
DRAFTED	T. SHEPARD 3-2-87	
CHECKED		
APPROV	WKD	4/23/87
RELEASE	K. Thomas	4/24/87

Delta Design
6778 KEARNY VILLA RD.
SAN DIEGO, CA
92123-1111

TITLE: CABLE ASSY — GPIB / RS-232C

SIZE	CODE IDENT		REV
C		1664574	A

SCALE NONE

SHEET 1 OF 1

DELTA DESIGN PART'S LIST BY ITEM

ASSEMBLY 16b4574010

DESCRIPTION CABLE ASSY,GPIB 30"

REF/DES

ITEM	PART NO.	DESCRIPTION	REF/DES	QTY
001	2000448	CONN RIBBON FEMALE PNL MTG 24 PIN (GPIB)		1
002	1700450	JACK SOCKET ASSY METRIC (GPIB)		2
003	1410111105	CONN,FEMALE,POLARIZE FLAT CABLE,26 POS		1
004	1410449105	STRAIN RELIEF FLAT CABLE,26 POS.		1
005	1410035109	CABLE,FLAT 28 AWG,26 CONDUCTORS		30
006	1500521	LABEL CABLE MARKING 1 IN X 3-3/4 IN SELF LAMINATING		2

ASSEMBLY 1e64574060
DESCRIPTION CABLE ASSY, RS232 30"
REF/DES

ITEM	PART NO.	DESCRIPTION	REF/DES	QTY
001	2000446	CONN D-STYLE FEMALE 25 SOCKETS (RS-232)		1
002	1700449	JACK SOCKET ASS: REAR PNL MOUNT		1
003	1410111105	CONN, FEMALE, POLARIZE FLAT CABLE, 26 POS		1
004	1410449105	STRAIN RELIEF FLAT CABLE, 26 POS		1
005	1410035109	CABLE, FLAT 28 AWG, 26 CONDUCTORS		30
006	1500521	LABEL CABLE MARKING 1 IN X 3-3/4 IN SELF LAMINATING		2

DELTA DESIGN PARTS LIST BY ITEM

ASSEMBL: 16e4574005

DESCRIPTION: CABLE ASSY, GPIB 20"

REF/DES:

ITEM	PART NO.	DESCRIPTION	REF/DES	QTY
001	2000448	CONN RIBBON FEMALE PNL MTG 24 PIN (GPIB)		1
002	1700450	JACK SOCKET ASSY METRIC (GPIB)		2
003	1410111105	CONN, FEMALE POLARIZE FLAT CABLE 26 POS		1
004	1410449105	STRAIN RELIEF FLAT CABLE 26 POS		1
005	1410035109	CABLE, FLAT 28 AWG, 26 CONDUCTORS		20
006	1500521	LABEL CABLE MARKING 1 IN X 3-3/4 IN SELF LAMINATING		2

ASSEMBLY 1660574055
DESCRIPTION CABLE ASSY,RS232 20"
REF/DES

ITEM	PART NO.	DESCRIPTION	REF/DES	QTY
001	2000446	CONN D-STYLE FEMALE 25 SOCKETS (RS-232)		1
002	1700449	JACK SOCKET ASSY REAR PNL MOUNT		1
003	1410111105	CONN,FEMALE,POLARIZE FLAT CABLE,26 POS		1
004	1410449105	STRAIN RELIEF FLAT CABLE,26 POS.		1
005	1410035109	CABLE,FLAT 28 AWG,26 CONDUCTORS		20
006	1500521	LABEL CABLE MARKING 1 IN X 3-3/4 IN SELF LAMINATING		2

CHAPTER 2
DRAWINGS AND PARTS LISTS

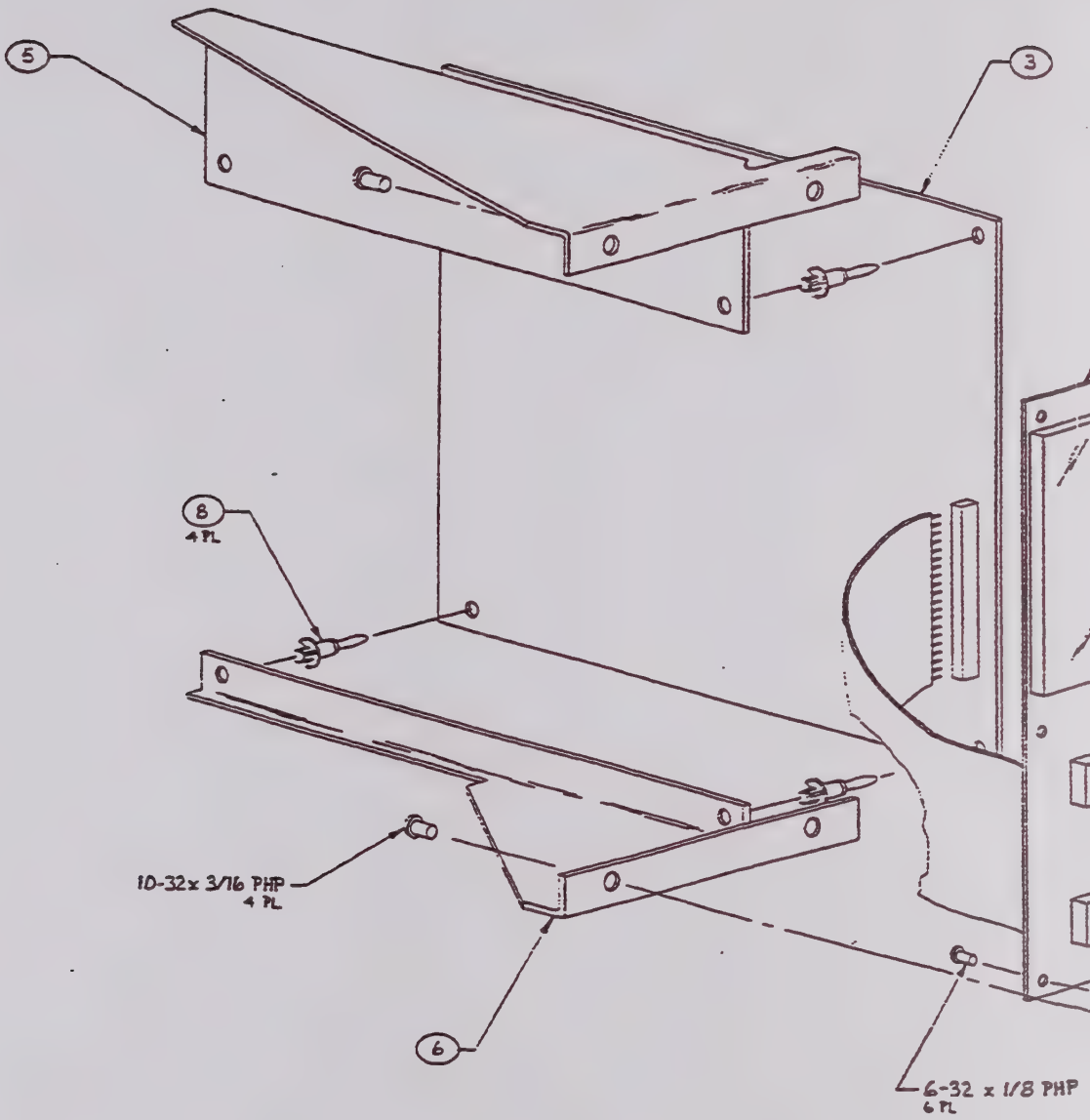
2.1 HOW TO USE

This section contains the drawings and parts lists associated with the 9010 Temperature Controller, and are listed in order of Top Assembly on down. Refer to these drawings whenever necessary for troubleshooting and repair, or when ordering parts. Please contact the Delta Design, Inc., Customer Service Department if more information is required.

DELTA DESIGN, INC.
5775 KEARNY VILLA RD.
SAN DIEGO, CALIFORNIA 92123-1111
TWX: 910 335-1216
FAX: (619) 277-7884
PHONE: (619) 292-5000

TABLE 2-1. DRAWINGS AND PARTS LISTS

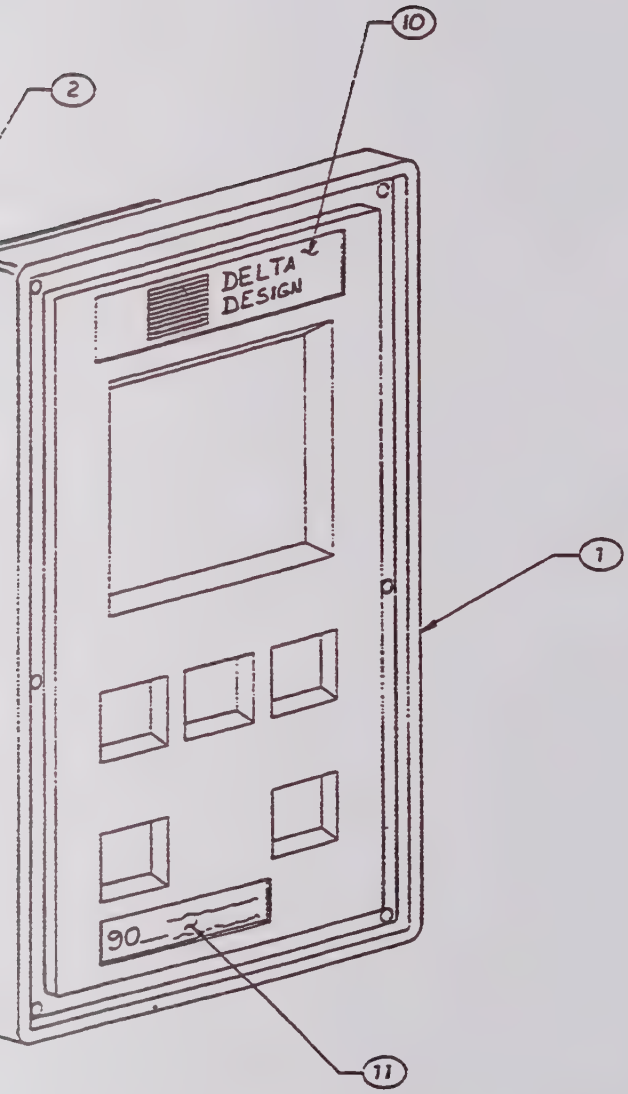
PART NUMBER	DESCRIPTION	PAGE
1663049-001	Temperature Controller Assembly	2-2
1663049-001	Parts List, Temperature Controller	2-3
1661866-501	PWB Assy, Front Panel Control	2-4
1661866-501	Parts List, Front Panel Control	2-5
1661863-000	Schematic, Front Panel Control	2-6
1661250-501	PWB Assy, Single Channel Temperature Controller	2-7
1661250-501	Parts List, Single Channel	2-8
1661247-000	Schematic, Single Channel Temperature Controller	2-10



⚠2 FINISH (IF APPLICABLE)

⚠1 MATL (IF APPLICABLE)

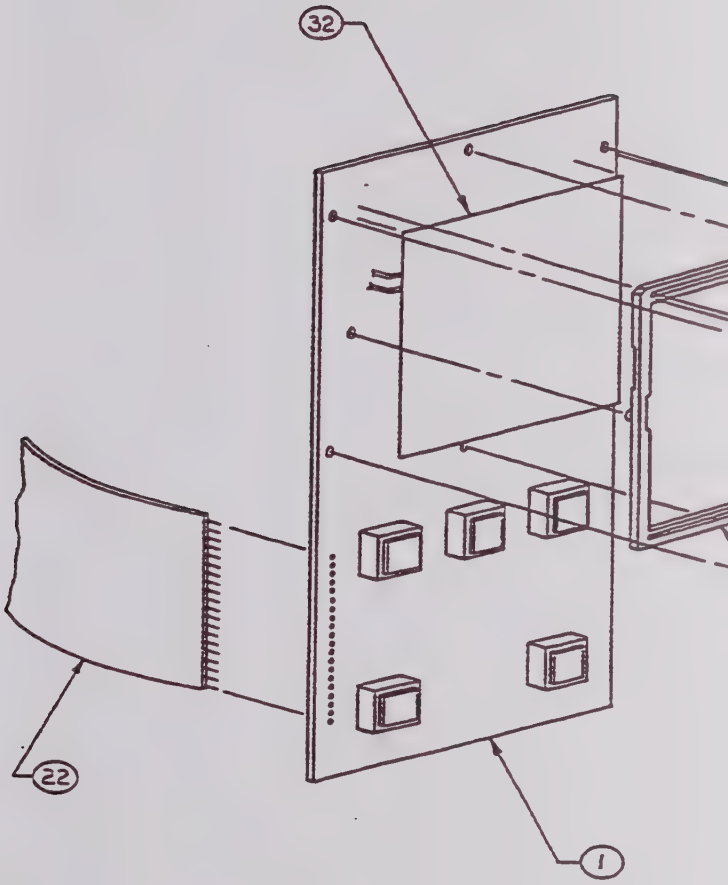
NOTES: UNLESS OTHERWISE SPECIFIED


10
2
DELTA
DESIGN
1
90
11

| | | |

ASSEMBLY 1663049001
DESCRIPTION 9010-TEMP. CONTROLLER
REF/DES:

ITEM	PART NO.	DESCRIPTION	REF/DES	QTY
001	1662651001	BEZEL, PAINTED FRNT. PNL, 9010, 9020		1
002	1661866501	PWA, FRNT. PNL, 9010		1
003	1661250501	PWA, TEMP. CONT, 1-CHNL		1
005	1661724101	BRKT, MTG, UPPER		1
006	1661723101	BRKT, MTG, LOWER		1
008	1501865	SUPPORT PCB NYLON LOCK-3/8 SPACE		4
010	1662698101	LABEL"DELTA LOGO"		1
011	1662684101	LABEL, LOGO-9010		1

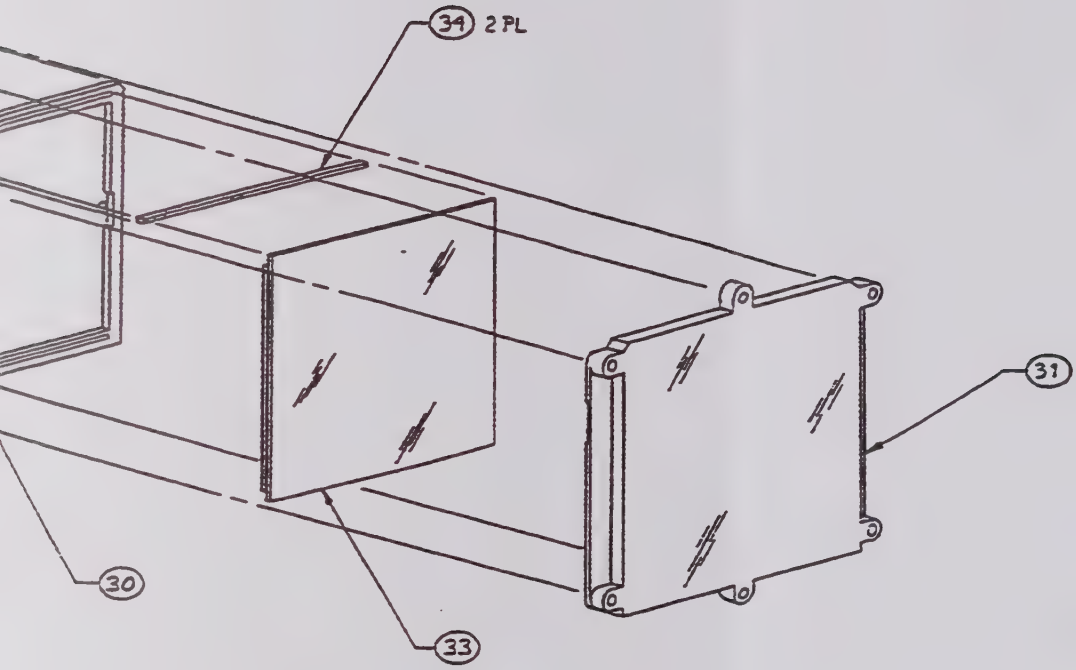


⚠2 FINISH (IF APPLICABLE)

⚠1 MATL (IF APPLICABLE)

NOTES: UNLESS OTHERWISE SPECIFIED

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPD
	A	ECN 7363	3/26/87	MC
	B	ECN 7397 T.S. 4-15-87	4/16/87	MC



PROPRIETARY NOTICE

INFORMATION CONTAINED ON THIS DRAWING IS PROPRIETARY TO DELTA DESIGN, INC. AND MAY NOT BE COPIED, REPRODUCED, FOR PARTS MADE THEREFROM WITHOUT WRITTEN PERMISSION FROM DELTA DESIGN, INC.

DASH	QTY	NEXT ASSY	USED ON	SERIAL NO.	DATE EFF	DWG REV
APPLICATION				EFFECTIVITY		

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON DECIMALS .XX ± .03 .XXX ± .010 ANGULAR ± 0°30'

HOLE TOLERANCES

MATERIAL

FINISH

ENGINEERING ACTIVITY ER# 7363

DESIGN		
DRAFTED	T. SHEPARD 12-22-86	
CHECKED		
APPROV		
RELEASE		

DO NOT SCALE DWG

Delta Design

6270 CORTE VILLA DR., SAN DIEGO, CA 92121-4111

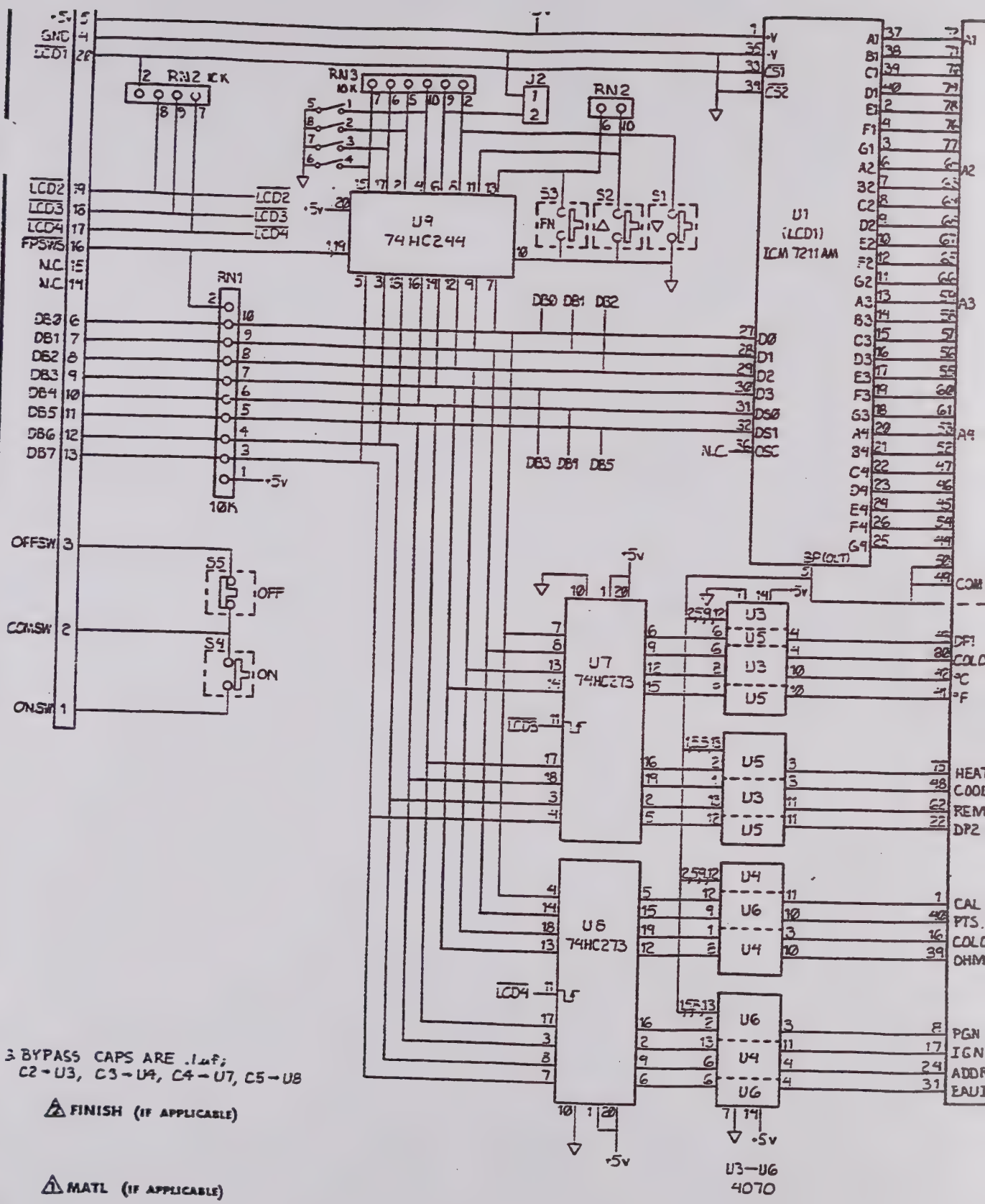
TITLE: PWA – FRONT PANEL

SIZE	CODE IDENT	DWG NO.	REV
D		1661866	B

SCALE 1/1 SHEET 1 OF 1

ASSEMBLY: 1661866501
DESCRIPTION: PWA, FRNT. PNL, 9010
REF/DES:

ITEM	PART NO.	DESCRIPTION	REF/DES	QTY
001	1661865401	PWB FRONT PANEL 9010, 9020		1
003	1661863000	SCHEMATIC-FRONT PNL TEMP CONTR		REF
005	1000581	IC 4 DIGIT DISPLAY DECODER DRIVER ICM7211AMIPL	U1, U2	2
006	1000580	IC EXCEL/GATE 4070	U3-U6	4
007	1000579	IC D-TYPE FLIP-FLOP 74HC273	U7, U8	2
008	1000538	IC	U9	1
012	0700000	CAP 10MFD 25VDC TANTALUM	C1	1
013	0800022	CAP CERAMIC .1MFD 50V 20% RADIAL LEAD	C2-C5	4
017	0400100	RES NTWK SIP 10K	RN1-RN3	3
020	1401298	SWITCH PB SPDT PCB MTG	SW1-SW5	5
021	1401188	SWITCH DIP SPST PCB 4 POS	SW6	1
022	1500373	CABLE ASSY FLAT FLEX .100CTR 20 POS JUMPR	J1	1
023	2000398	CONN HDR STR 100 PCB 2P	J2-J4	3
025	1000582	IC INVERTER DC-AC 3 TO 6.25VDC 120mA INPUT LPS05-1-2	T1	1
030	1661705101	RETAINER, LCD CONN.		1
031	1661706101	BEZEL, LCD		1
032	1663519101	BACKLIGHT, LCD		1
033	1663520101	LCD, TEMP. CONT.		1
034	2000434	CONNECTOR LCD(ZEBRA)		2



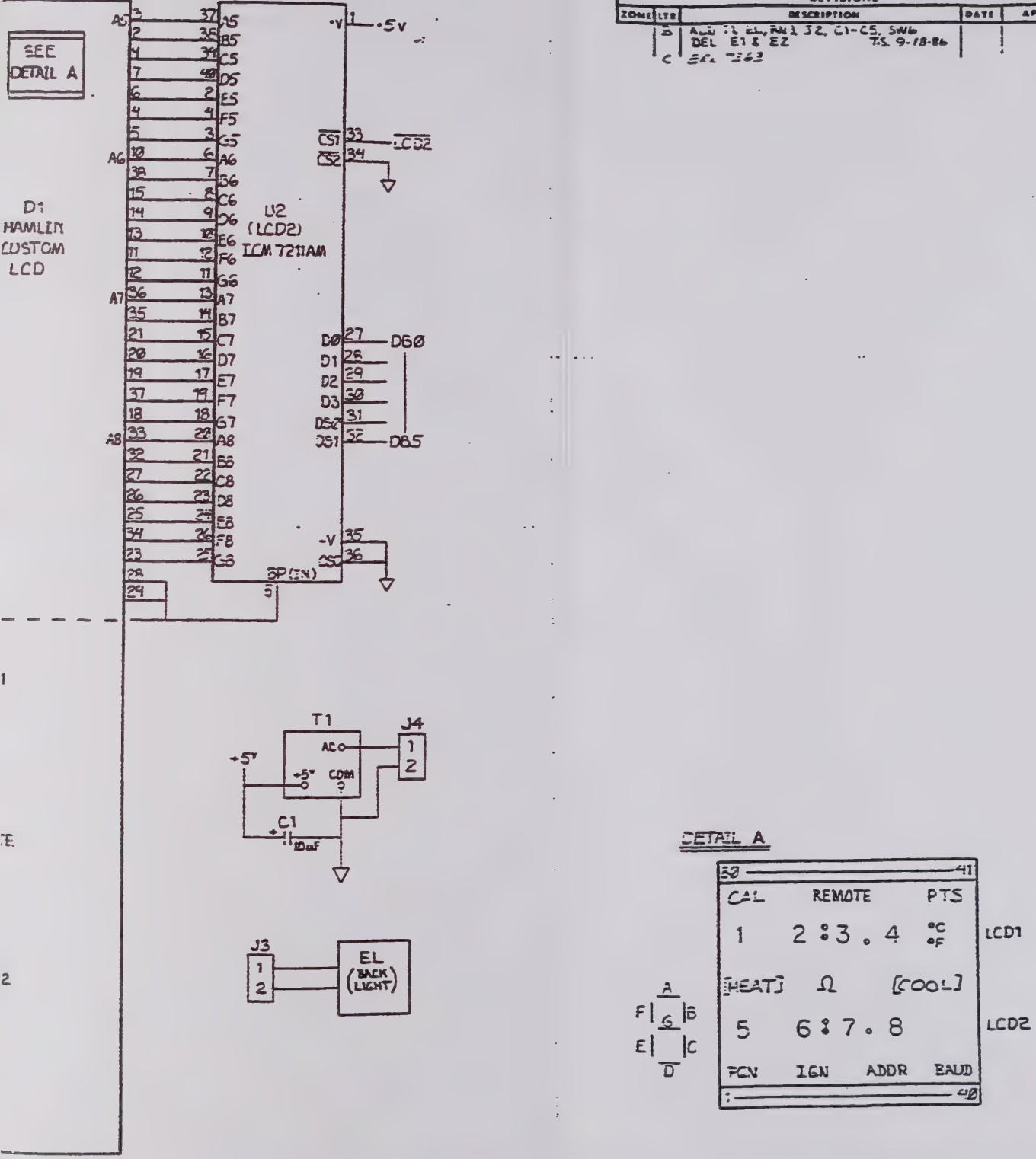
3 BYPASS CAPS ARE .1uf;
C2 → U3, C3 → U4, C4 → U7, C5 → U8

⚠ FINISH (IF APPLICABLE)

⚠ MATL (IF APPLICABLE)

NOTES: UNLESS OTHERWISE SPECIFIED

ZONE	LTR	DESCRIPTION	DATE	APPD
	B	ADD R1 R2, RN1 J2, C1-C5, SW6 DEL E1 & E2 TS 9-18-86		
	C	ECL 7363		



DETAIL A

DASH QTY	NEXT ASSY	USED ON	SERIAL NO.	DATE EFF	DWG REV	MATERIAL					
APPLICATION			EFFECTIVITY			FINISH					

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON DECIMALS .XX ± .03 .XXX ± .010 ANGLES ± 30' HOLE TOLERANCES

ENGINEERING ACTIVITY	ERN7363
DESIGN	ART HANSON
DRAFTED	CL RUKSTELIS
CHECKED	
APPROV	
RELEASE	
DO NOT SCALE DWG	

DELTA DESIGN INC.
A DIVISION OF GENCO INC.
SAN DIEGO, CA. 92123

TITLE: SCHEMATIC — FRONT PANEL TC1

SIZE	CODE IDENT	
D		1661863

SCALE NONE

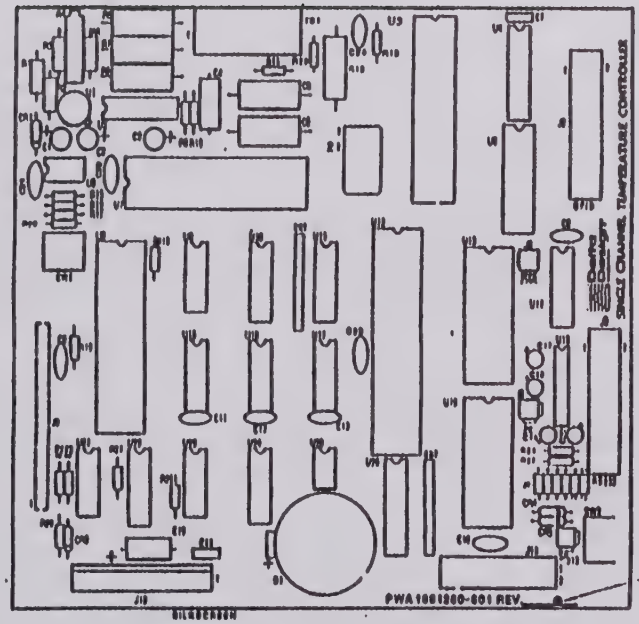
SHEET 2-6

DELTA DESIGN

PARTS LIST BY ITEM
ASSEMBLY: 1661250501
DESCRIPTION: PWA, TEMP. CONT, 1-CHNL
REF/DES:

ITEM	PART NO.	DESCRIPTION	REF/DES	QTY
001	1661249401	PWB, TEMP. CONT. 1-CH		1
003	1661247000	SCHEMATIC SGL CHAN TEMP CONTR		REF
005	1206537	XSTR DUAL PNP IT137	U1	1
006	1000577	IC TRIPLE 2-CH ANA MULTIPLEXER/DEMULTI-PLEXER 4053	U2	1
007	1000549	IC GPIB CONTR TMS9914A	U3	1
008	1000547	IC GPIB DRIVER SN75160A	U4	1
009	1000546	ICC GPIB DRVR SN7516 GPIB DRVRX	U5	1
010	1000514	IC ICL7660 CPA	U6	1
011	1000566	IC A/D CONV 12-BIT ICL7109CPL	U7	1
012	1000521	IC 68681	U8	1
013	1000539	IC DECODER 3 LINE TO 8 LINE 74HC138	U10, U14, U24	3
014	1000537	IC ENCODER 8 TO 3 LINE PRIORITY 74HC148	U11	1
015	1000525	IC 68008	U12	1
016	1664605001	IC, PROGRAMMED	U13	1
017	1000563	IC DUAL SYNCH BIN COUNTER 74HC393	U15	1
018	1000165	IC, SN7407	U16	1
019	1000179	IC SN74LS74A	U17	1
020	1000576	IC +5V DUAL RS-232 XMTR/RCVR MAX 232CPE	U18	1
021	1000565	IC SRAM 150NS UPD4464C-15L	U19	1
022	1000523	IC 74HC02	U21	1
023	1000527	IC CD4020	U22	1
024	1000564	IC HEX INV 74HC04	U23	1
025	1000578	IC NONVOLATILE CON-TROLLER DS1210	U25	1
026	1000562	IC OCTAL BUS XCVR NON INV 74HC245	U26	1
027	1000561	IC AND GATE QUAD 2 INPUT 74HC08	U9	1
030	0701000026	CAP TANTALUM 10MFD 25V	C1, C2, C3	3
031	0800033	CAP METAL POLYPROP .10MF 100V	C4	1
032	0800035	CAP METAL POLYPROP .68MFD 100V	C5, C6	2
033	0800022	CAP CERAMIC .1MFD 50V 20% RADIAL LEAD	C7, C8, C11-13, C16,	10
034	0800032	CAP CERAMIC 1 MFD 100V	C14	1
035	0700000	CAP 10MFD 25VDC TANTALUM	C15	1

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPD
	A	REVISED - ADDED Z1 RZ9 I.S. 1-1-86		
	B	ERN 7363		
	C	ECN 7392 IS 4 6-87	1/14/87	



△ MARK CURRENT REV LEVEL OF ASSY DWG USING BLACK INDELIBL , WHERE SHOWN.

DASH	QTY	NEXT ASSY	USED ON	SERIAL NO.	DATE EFF	DWG REV
501	1		MARK II			

APPLICATION

EFFECTIVITY

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON DECIMALS .XX ± .03 .XXX ± .010 ANGLES 0°30'

HOLE TOLERANCES

ENGINEERING ACTIVITY		
ERN 7363		
DESIGN		
DRAFTED	T. SHEPARD	7-1-86
CHECKED		
APPROV		7/15/86
RELEASE		7/17/86

DO NOT SCALE DWG

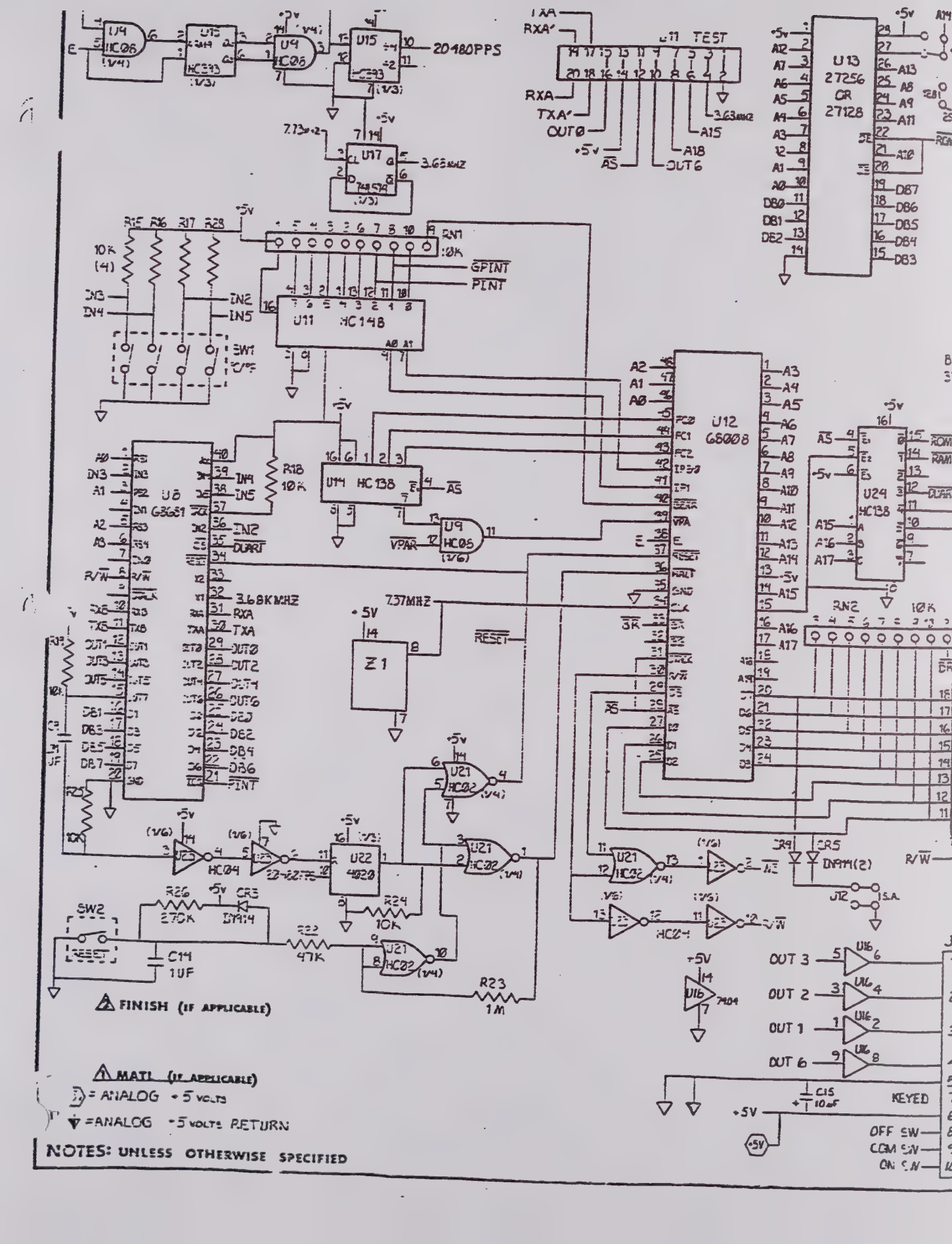
DELTA DESIGN INC.
A SUBSIDIARY OF CONTROL DATA CORP.
SAN DIEGO, CA. 92138

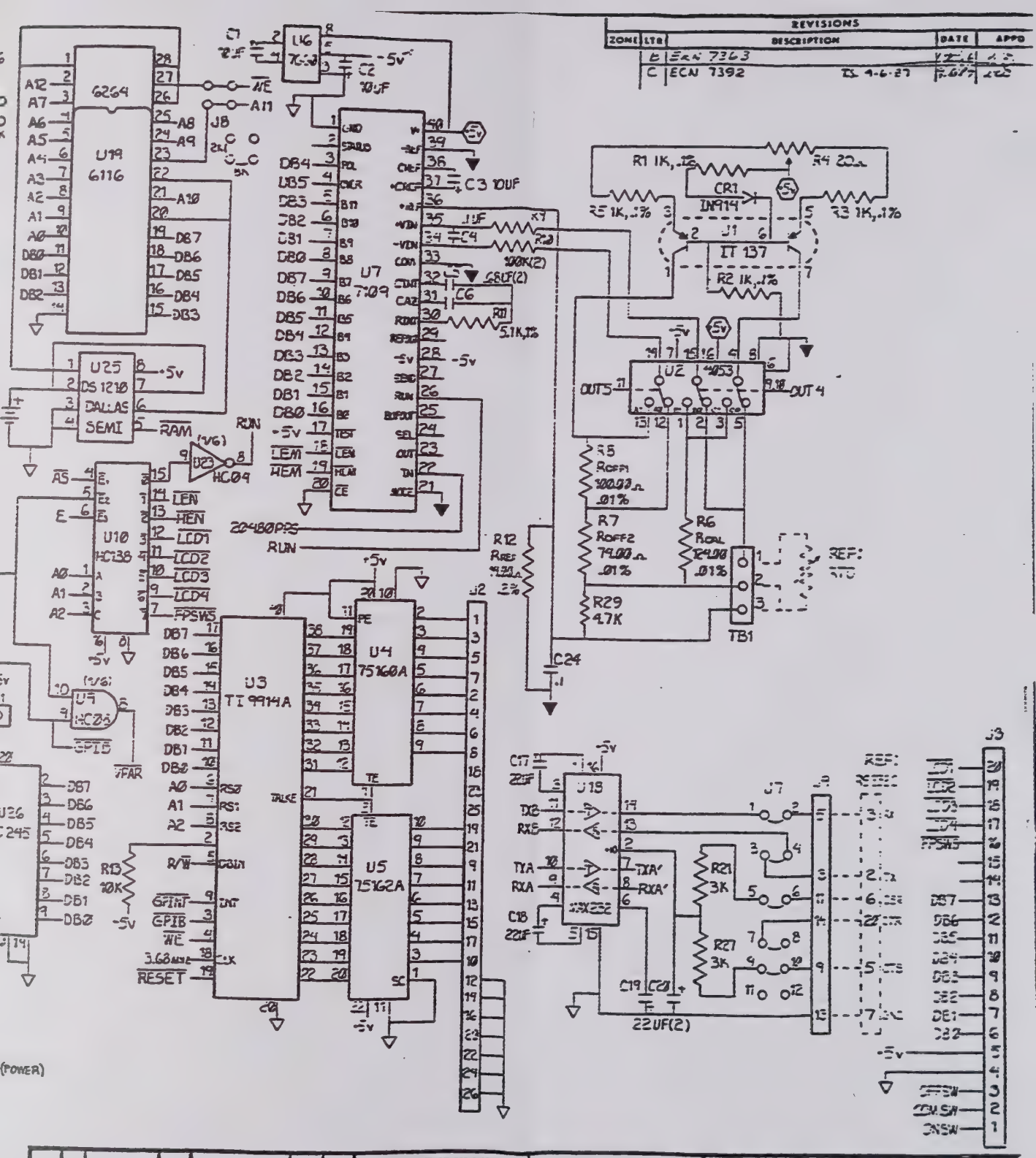
TITLE: PWA – SINGLE CHANNEL TEMPERATURE CONTROLLER

SIZE	CODE IDENT		REV
C		166125[illegible]	-

PARTS LIST BY ITEM
ASSEMBLY: 1661250501
DESCRIPTION: PWA, TEMP. CONT, 1-CHNL
REF/DES:

ITEM	PART NO.	DESCRIPTION	REF/DES	QTY
036	0800024	CAP, 22UF, TANT	C17-C20	4
037	0800051	CAP CERAMIC .01MFD 50V 20% RADIAL	C9	1
040	1421100114	RES METAL FILM 1.0 K 1/4W 0.1%	R1-R3, R5!	4
041	0500066102	POT, 20 OHM	R4	1
042	0400127	RES PREC WIREWOUND 124 OHM 1/2W .01%	R6	1
043	0400126	RES PREC WIREWOUND 74 OHM 1/2W .01%	R7	1
044	0400125	RES PREC WIREWOUND 100 OHM 1/2W .01%	R8	1
045	0310034500	RES, 100K, 1/4W, 5%	R9, R10	2
046	1421499114	RES METAL FILM 4.99K 1/4W 1%	R11	1
047	0400124	RES PREC WIREWOUND 14 OHMS 1/2W .01%	R12	1
048	0301034500	RES 10K 1/4W 5%	R13, R15-R19, R24, R25,	9
049	1410370184	RES FIXED FILM 3K 1/4W 5%	R21, R27	2
050	1410370212	RES FIXED FILM 47K 1/4W 5%	R22	1
051	1410370244	RES, FIXED FILM 1MEG 1/4W 5%	R23	1
052	1410370230	RES FIXED FILM 270K 1/4W 5%	R26	1
053	0304724500	RES, 4.7K, 1/4W, 5%	R29	1
054	0400100	RES NTWK SIP 10K	RN1, RN2	2
058	1100914	DIODE 1N914	CR1, CR3, CR4, CR5	4
060	1401305	OSC XTAL TTL CLOCK 7.3728 MHZ	Z1	1
063	1401188	SWITCH DIP SPST PCB 4 POS	SW1	1
064	1401295	SWITCH PB PCB	SW2	1
068	1401300	BATTERY LITHIUM 3V	B1	1
072	2000338	CONN, PWB, MALE HEADER	J2, J9	2
073	2000428	CONN RCPT SIP STRIP 20 PIN PCB MTG 010SP	J3	1
074	2000427	CONN HDR STR 156 SP PCB MTG 10 POS 045SG	J10	1
075	2000348	CONNECTOR, MLE 20 PIN	J11	1
076	2000403	CONN HDR STPLN STR DBL .100	J12	2
077	1400397	TERMINAL BLOCK 3POS PCB MTG SINGLE POST .375 SPACING	TB1	1
080	2500089104	SOCKET, DIP, 16 PIN	XU22	1
081	2500089106	SOCKET, DIP, 20 PIN	XU26	1
082	2500089109	SOCKET, DIP, 28 PIN	XU13	1


U4 HC08
U15 HC393
U15 HC393
20480PPS
U17 74LS74
3.68MHZ
TXA
RXA
TEST
RXA
TXA
OUT0
AS
A18
OUT6
A15
3.68MHZ
U13 27256 OR 27128
DB7
DB6
DB5
DB4
DB3
R15 R16 R17 R28
10K (4)
RN1 10K
GPINT
PINT
U11 HC148
SW1
U8 G3681
U14 HC138
R18 10K
U9 HC05
VPAR
U12 68008
U24 HC138
RN2 10K
7.37MHZ
Z1
RESET
U21 HC02
U22 4020
U23 HC04
R26 270K
CR3 IN914
SW2
RESET
C14 1UF
R22 47K
R24 10K
R23 1M
CR9 CR5 IN914(2)
R/W
U16 7404
OUT 3
OUT 2
OUT 1
OUT 6
C15 10uF
KEYED
OFF SW
COM SW
ON SW
FINISH (IF APPLICABLE)
MATL (IF APPLICABLE)
= ANALOG +5 VOLTS
= ANALOG +5 VOLTS RETURN
NOTES: UNLESS OTHERWISE SPECIFIED


REVISIONS
ZONE | LTR | DESCRIPTION | DATE | APPD
B | ECN 7363
C | ECN 7392 | 4-6-87
U19 6116
6264
U25 DS 1210 DALLAS SEMI
U7 7109
U10 HC138
U23 HC04
U9 HC08
U3 TI 9914A
U4 75160A
U5 75162A
U18 MAX232
U2 4053
IT 137
CR1 IN914
TB1
J8
J3
R1 1K,.1%
R2 1K,.1%
R3 33 1K,.1%
R4 20Ω
R5 Roff1 100.00Ω .01%
R6 Rcal 24.00Ω .01%
R7 Roff2 79.00Ω .01%
R10 5.1K,1%
R12 Rref 9.31Ω 2%
R13 10K
R21 3K
R29 4.7K
C1 .1UF
C2 10UF
C3 10UF
C4 .1UF
C6 .68UF(2)
C17 22UF
C18 22UF
C19 C20 22UF(2)
C24 .1
-5V
+5V
RUN
RAM
RESET
GPIB
20480PPS
3.68MHz
REF:
DELTA DESIGN INC.
ENGINEERING ACTIVITY
ERN 7363
DESIGN ART RACKOW
DRAFTED D.L. RUKSTELIS 3/19/87
CHECKED
APPROV
RELEASE
TITLE: SCHEMATIC, TEMP 1 CHANNEL
SIZE D
CODE IDENT
1661247
REV C
SCALE
2-10
DO NOT SCALE DWG
MATERIAL
FINISH
APPLICATION
EFFECTIVITY
NEXT ASSY
SERIAL NO.
DATE EFF
DWG REV

CHAPTER 5
9010 TEMPERATURE CONTROLLER

5.1 GENERAL DESCRIPTION

The Delta Design, Inc., 9010 Temperature Controller has been specifically designed for use with the Delta 9000 Series Environmental Chambers. It works in conjunction with the Auxiliary Module that is part of the 9000 Series chambers.

The 68008 microprocessor-based controller uses a platinum RTD sensor circuit to convert the chamber temperature first to resistance, then to voltage, and then to a digital value that the program can use. That temperature value is then compared to a setpoint temperature entered by way of the front panel or via the remote interfaces.

The two values, the measured chamber temperature, and the desired temperature or setpoint, are usually displayed on the LCD of the front panel. It is the difference between these two values, however, that drives the thermal system with heated or cooled air to bring the chamber temperature to the setpoint. How it drives the system depends on several parameters which may be changed by the user. Some of the features of the 9010 are listed in Table 5-1.

TABLE 5-1. SPECIFICATIONS AND FEATURES

TEMPERATURE RANGE	-184 to +315 degrees C
RESOLUTION	0.1 degree C or F
REPEATABILITY	+/- 0.25 C (4 hr min.)
ACCURACY	+/- 0.4 degrees C
CALIBRATION PERIOD	6 months minimum

TABLE 5-1. SPECIFICATIONS AND FEATURES (Continued)

1. Rate of temperature change controllable from 0.1 degree C per minute up to the chamber maximum.

2. Continuous setpoint entry with 0.1 degree resolution or selection from a list of up to ten programmed temperatures.

3. Ten Step Program that can be repeated up to 9999 times. Each step consists of temperature, time at temperature, and rate to get to temperature. Soak time up to 100 hours.

4. Built in test features.

5. Three interfaces: front panel, RS-232 and IEEE-488. A terminal on the RS-232 can be used simultaneously with either front panel operation or computer control via the IEEE-488.

6. Seven point temperature correction curve can be entered thru all three interfaces to correct the measured temperature over the full temperature range.

7. Programmable upper and lower temperature limits set the window of operation. No setpoints are accepted outside the window. Heat and Cool turned off when five degrees C outside of the window.

8. Front panel interface can be in Celsius or Fahrenheit.

9. LCD is backlit and protected by a polycarbonate cover with an anti-glare surface for good visibility under all lighting conditions.

10. A Platinum RTD is used with a dual range circuit of precision components, that is autoswitched by the program, to provide good measurement resolution over the large temperature range of 500 degrees C, while maintaining good accuracy at the extremes.

5.2 9010 COMMUNICATION

There are three ways to communicate with the 9010:

1. User direct thru the front panel.

2. Dumb terminal via the RS-232.

3. Computer control via the GPIB or RS-232.

Front panel operation requires no additional equipment. Operation can be tailored for a particular installation. Access to some parameters can be restricted.

Terminal operation requires a terminal or a computer programmed to appear as a terminal. Using the command list, parameters may be displayed or changed with a few keystrokes. The user has access to all parameters.

Computer control via the GPIB permits great flexibility in test setup. Chamber control and monitoring can be combined with data acquisition via test instruments on the DUT.

Remote operation by terminal or computer will be discussed in the next chapter.

5.2.1 FRONT PANEL OPERATION (Figure 5-1)

In addition to the FCN, UP and DOWN keys, the dip switches of SW1 in Figure 5-1 affect the operation thru the front panel. All four switches are set to OFF when a 9010 is delivered in a chamber.

Figure 5-2, Normal Access, is one of four drawings that attempt to show the operation flow for all key sequences. They will be referred to in the discussion following this general introduction.

There are three levels of front panel access: NORMAL, EXTENDED, and FULL ACCESS.

5.2.1.1 NORMAL

Allows entering a setpoint and turning on and off the heat and cool control. The Rate Program can be started and stopped as well.

If no keys are pressed after startup, this is what one gets - NORMAL access. If the UP key is pressed during the time all the LCD is on, after startup, then the access is EXTENDED.

5.2.1.2 EXTENDED

In addition to the normal functions, some other less frequently changed parameters can be accessed.

5.2.1.3 FULL

Access to the remaining parameters can be made more difficult so that they are not accidently changed by an unknowledgeable operator.

5.2.1.4 FRONT PANEL FUNCTIONAL ACCESS

The parameters accessible are outlined below. NOTE: How SW1-2 is used to change the parameters that are accessible from the front panel.

5.2.1.4.1 If (Neither FCN nor UP key pressed during startup), NORMAL ACCESS:

```
* Heat and Cool control.
   If (SW1-2 OFF)
*        Continuous Setpoint.
  Else
*        List of Setpoints.
   If (SW1-2 ON and Program Repeats not zero)
*        Start/Stop Rate Program.
```

5.2.1.4.2 Else if (UP key pressed during startup - when LCD on), EXTENDED Access:

It adds:

* GPIB address.
* RS-232 baud rate.
* High Temperature Limit.
* Low Temperature Limit.
* Control Rate.

5.2.1.4.3 Else if (FCN key pressed during startup and SW1-3 OFF), FULL Access:

It adds:

* Proportional Gain.
* Integral Gain.

If (SW1-2 OFF)

* Calibration Points.
* Check analog circuit.

Else

* Rate Programmer Steps.
* Program Repeats.

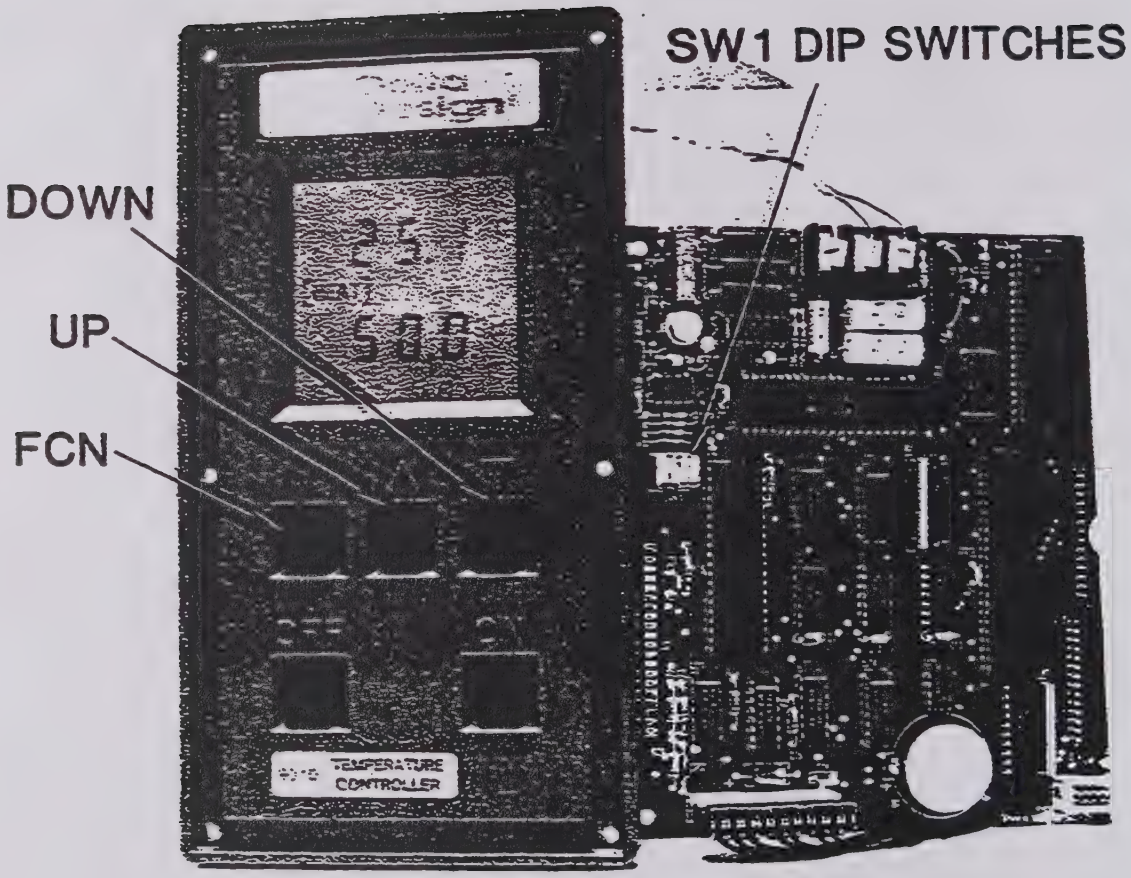


Figure 5-1. 9010 Front Panel Controls

5.3 NORMAL ACCESS MODE (Figure 5-2)

This mode is entered if the user simply powers up the chamber by pushing the "ON" button. The LCD (Liquid Crystal Display) will show all the possible display segments for two seconds during startup, and then two four digit numbers momentarily before going to the main display labeled "A" on the drawing. The top number is the chamber selected by the dip switches on the front panel board, and the bottom number is the program version (given as year and week of year). DIP switch #4 on the main board selects whether degrees C or F will be used by the front panel interface. Holding down the DOWN key on startup will switch the degree type until the next startup.

5.3.1 DIP SWITCH SETTINGS ON SW1

In the following, it is assumed that the SW1 dip switches on the main board are set as shown on the drawing so that:

1. 1 is OFF: "TEST" mode is not selected (described later in this chapter).

2. 2 is OFF: Rate Program not selected.

3. 3 is OFF: Front panel FULL access allowed.

4. 4 is OFF: Default degrees Celsius selected.

5.3.2 MAIN DISPLAY

Display "A" shows the measured temperature on the top and the desired temperature on the bottom. The 9010 will revert to this display if the keyboard becomes inactive for more than 15 seconds.

5.3.3 HEAT AND COOL CONTROL

On startup, HEAT and COOL control will always be disabled. When it is enabled, the main display shows which control line is ON and for how long, by turning on the HEAT and COOL words. To enable control, the FCN key (unlabeled) is first pressed to get to display "B", and then the UP and DOWN keys are used to toggle the HEAT and COOL words in this display. When the words are ON, returning to the main display by pressing the FCN key, will enable the selected control.

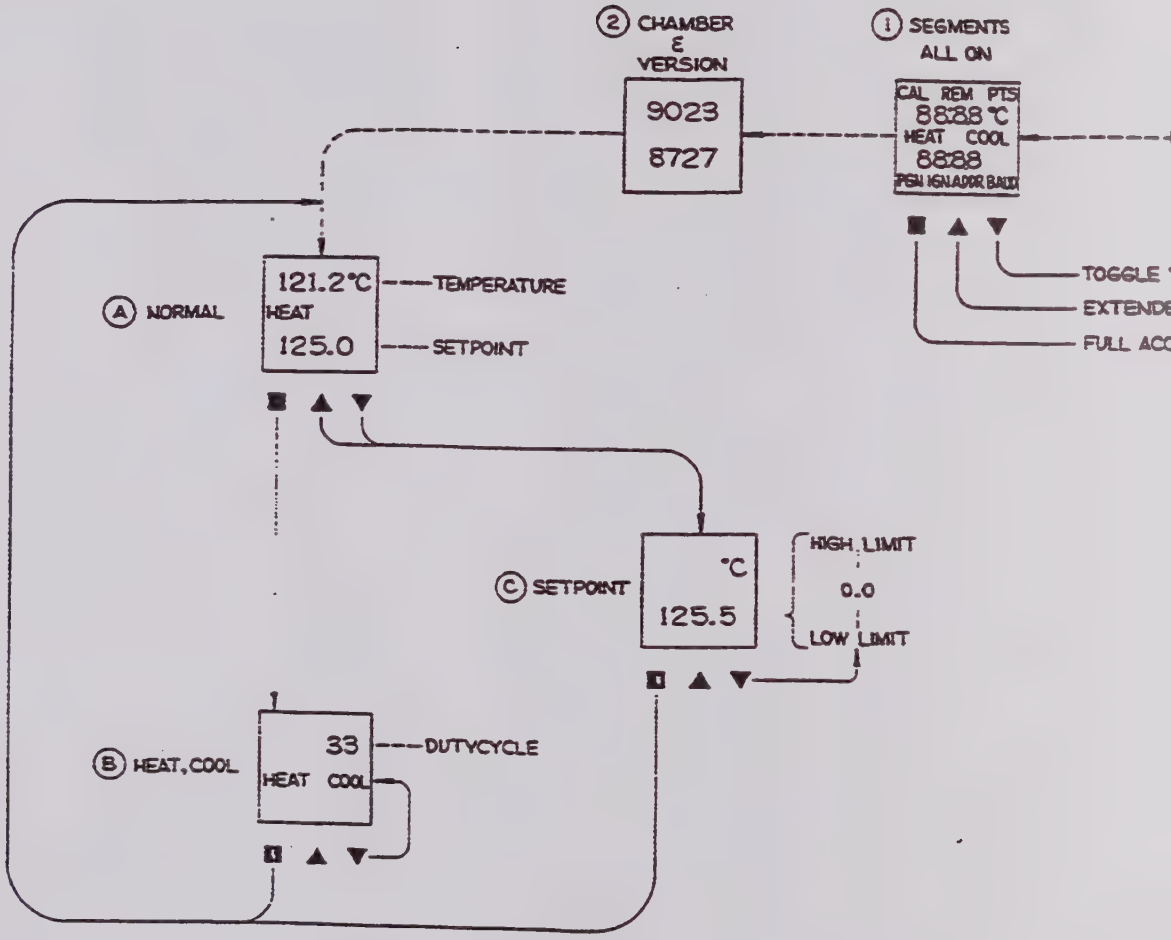
5.3.4 DUTYCYCLE

The Dutycycle number that is shown in display "B" is for information only. It is the percent of the control cycle that either HEAT or COOL is on; a negative number indicates cooling.

5.3.5 SETPOINT TEMPERATURE

Once back in the main display, the setpoint temperature can be changed by first pushing either the UP or DOWN buttons to get to display "C". The drawing indicates that the setpoint can be set to any temperature between two limits. Trying to go outside this range will cause "wraparound" through the other limit. These two limit points are initially set at -60 and 220 degrees C. They can be changed in the EXTENDED or FULL ACCESS operational modes.

The UP and DOWN keys operate in 3 "speeds". Single key presses will make changes in tenths of a degree. Holding the key down will start auto-change by one degree for a few seconds and then shift to auto-change by ten degrees. As mentioned before, no parameter change will actually take place until the FCN key is pressed moving on to the next display.



⚠ FINISH (IF APPLICABLE)

⚠ MATL (IF APPLICABLE)

NOTES: UNLESS OTHERWISE SPECIFIED

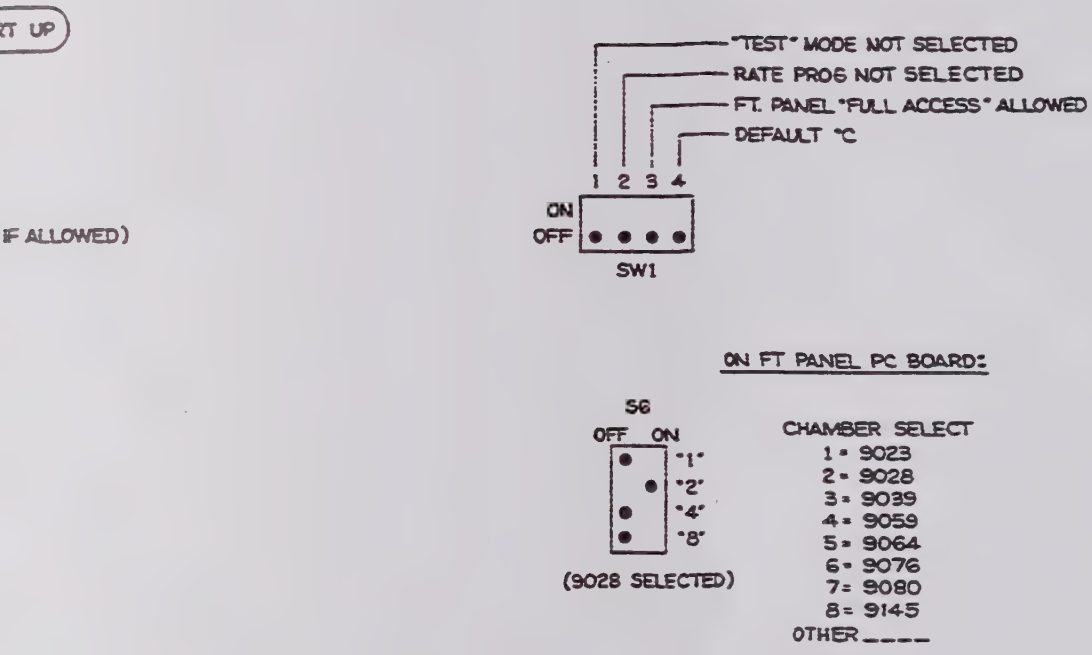


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Figure 5-2. Normal Access

5.4 EXTENDED ACCESS MODE (Figure 5-3)

This mode has all the functions of NORMAL mode. In addition, both the high and low temperature limits can be changed, as well as the GPIB address and the RS-232C baud rate. To operate in this mode, the UP key must be pressed sometime during the Startup, when all the segments are turned on.

As the drawing shows, the five additional displays (labeled D, E, R, F and G) are entered after leaving the Setpoint display "C". To get to the temperature limit displays "D" and "E", the Setpoint display "C" must have been entered with the UP key.

5.4.1 HIGH AND LOW TEMPERATURE LIMITS

The High Temp and the Low Temp have their limits as noted in the drawing. The three speed operation of the UP and DOWN change keys is the same as for the Setpoint. Again, the change does not take effect until leaving the display with the FCN key.

5.4.2 CONTROL RATE

Display "R" shows the default value of 0.0 indicating that the rate is not being controlled. All other values from 0.1 to 36.0 must be entered on power up. This feature permits heating and cooling at rates from 0.1 degree C per minute, up to the chamber maximum.

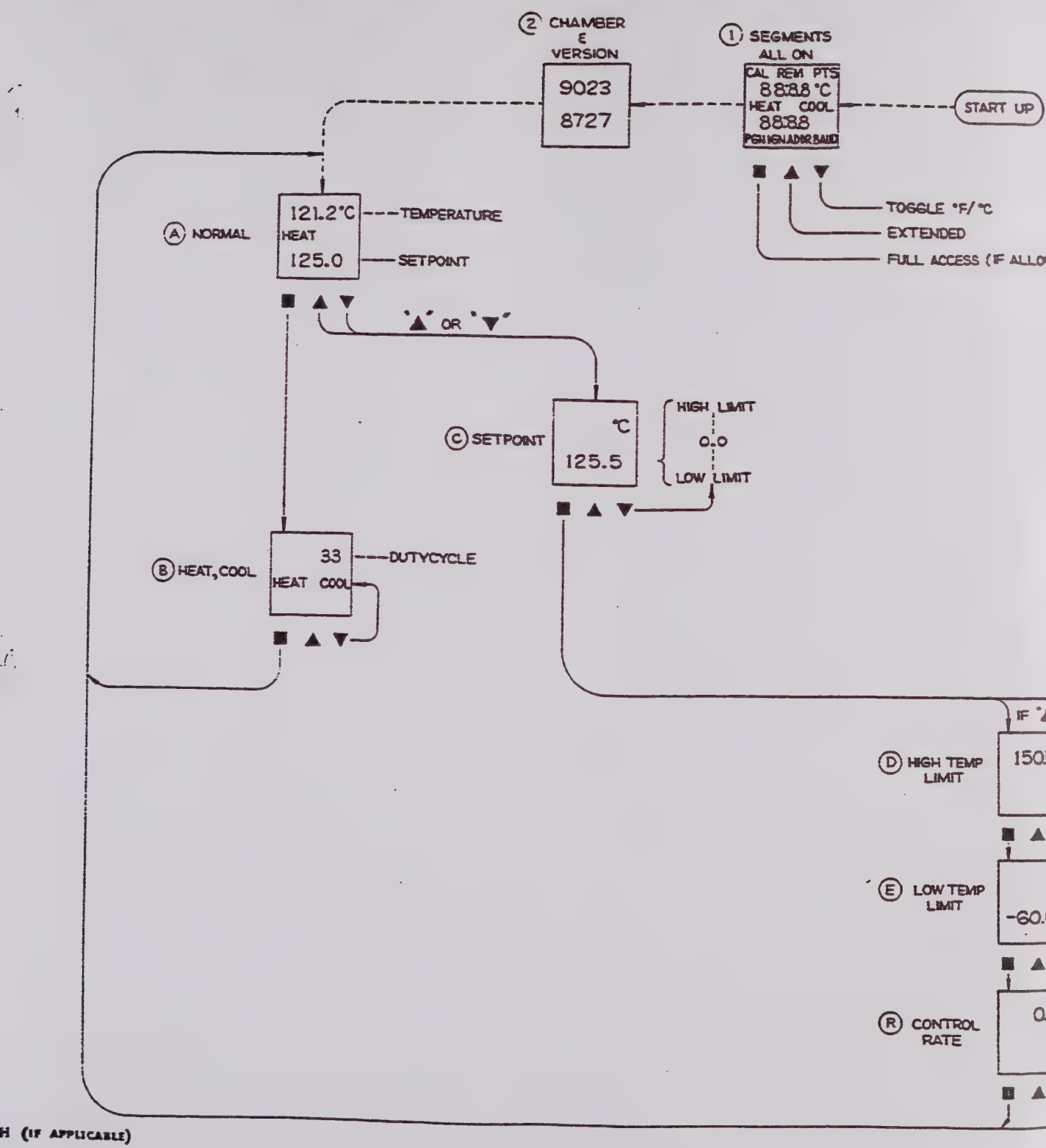
5.4.3 GPIB ADDRESS

If the Setpoint display had been entered with the DOWN key, then, on leaving display "C", display "F" will appear. The address that the 9010 will use to communicate on the IEEE-488 bus can now be selected. The UP and DOWN keys operate in two speeds to cover just the range of addresses shown on the drawing.

5.4.4 RS-232 BAUD

On leaving display "F", display "G" will appear. A baud rate for communicating over the RS-232C link can be selected from a list of possible rates, as shown on the drawing. Pressing the FCN key will cause the main display to reappear.

Turning the 9010 off and on again will return the mode to NORMAL with all parameters saved by the battery backed-up memory.



H (IF APPLICABLE)

PLICABLE)

SS OTHERWISE SPECIFIED

900

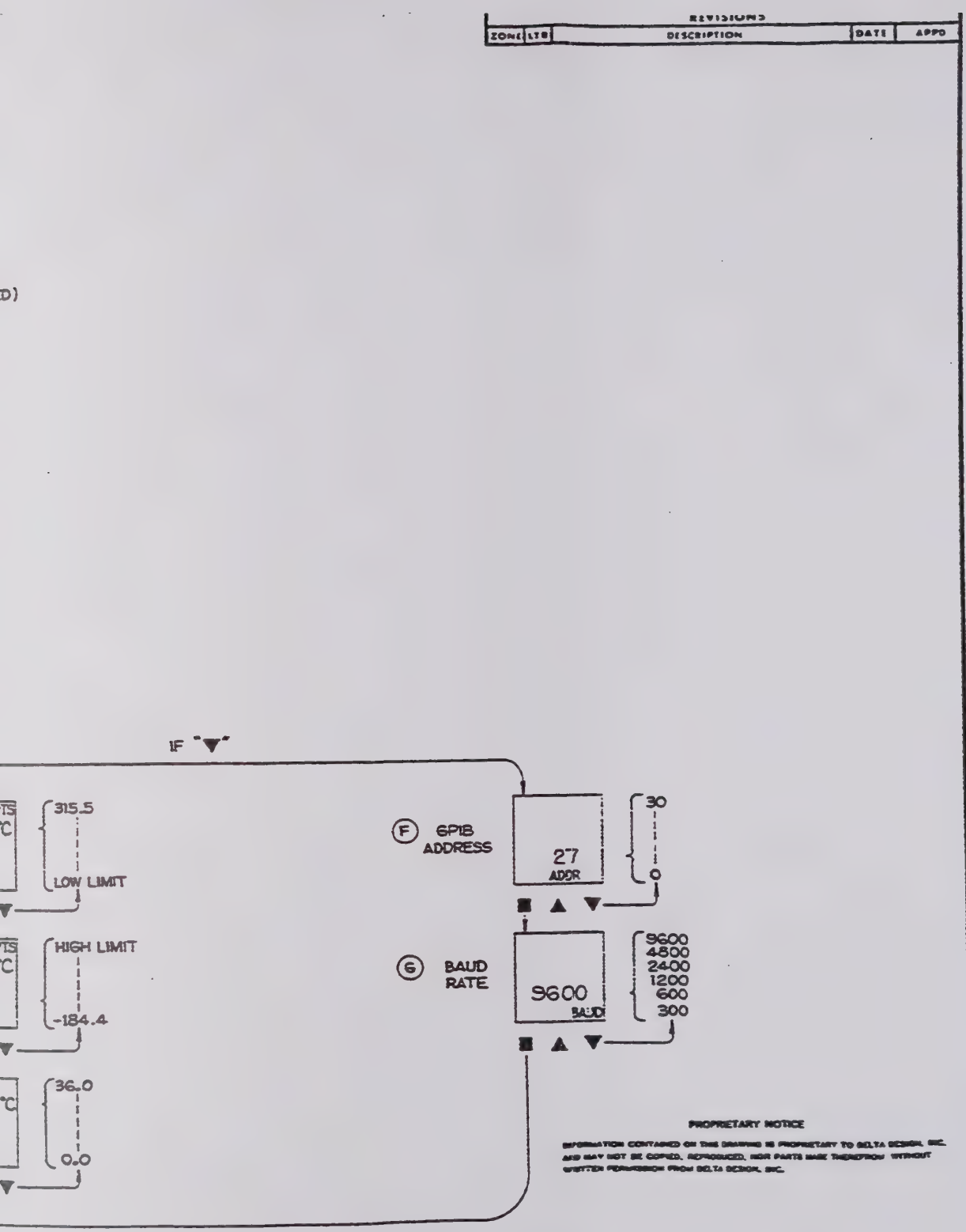


Figure 5-3. Extended Access

5.5 FULL ACCESS MODE (Figure 5-4)

This mode should only be accessed to change the chamber control dynamics or for calibration. In addition to the functions of EXTENDED mode, it allows changing the control gains and adding a temperature correction curve.

To enter this mode, press the FCN key during startup, when all the display segments are ON. If Full Access is not disallowed by DIP switch #3 on the main circuit board, the mode will be entered. Refer to the drawing for the following descriptions.

5.5.1 PGN and IGN

Entry to this series of displays is made by going to the setpoint display via the UP key, when in the FULL ACCESS mode.

The two gains (proportional and integral) determine the dynamics of control around the setpoint. They should be matched to the particular chamber in which the 9010 is used. Permissible values, as shown alongside display drawings "H" and "I", are 0 thru 9. Selecting a chamber with the dip switches on the front panel board, sets the default values for that chamber. Any changes to those values will be remembered. Determining the gains is somewhat of an art. The default values should not need to be changed, but if they are, NOT radically.

5.5.2 ANALOG CIRCUIT CHECK

The first display "J" is somewhat unusual. It shows what resistance the analog circuit is measuring at its three terminal connector. The Platinum Resistance Temperature Detector is connected there. Pressing the UP key will, however, switch-in a precise 124 ohm resistor and switch the dual range measuring circuit to the HIGH range. Pressing the DOWN key will show how the LOW range measures the 124 ohm resistor. The two readings should agree within 0.2 ohms. Pressing the UP and DOWN in turn several times may bring the readings closer. If they are still in poor agreement, there is a problem with the analog circuit. See the maintenance section for more information.

Pressing the FCN key will switch the RTD back in the circuit and go on to the calibrate displays.

Display "J" is the only one that will not revert to the main display after 15 seconds. The FCN key must be pressed to exit this display.

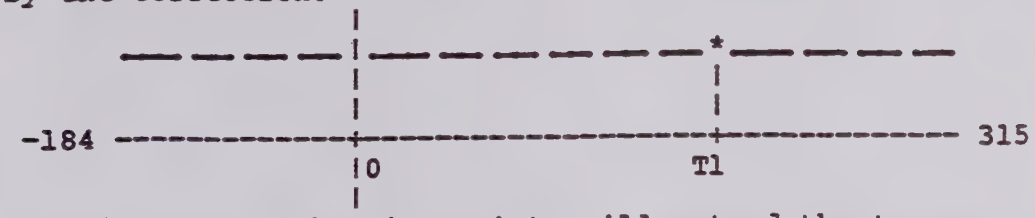
5.5.3 CALIBRATION POINTS

The "K" displays are the currently entered points that determine the correction curve. (The drawing shows three, but there may be 0 to 7.) The "K" displays are ordered by temperature, with the lowest temperature first. Looking at display "K1" on the drawing, the temperature of point #1 is -35.4 and the correction is 1.2 degrees. That means that a temperature that would have been reported as -35.4 before, will now be reported as -35.4 + 1.2 = -34.2 degrees. The UP and DOWN keys will only toggle the correction to a P.O. (for Point Out) display and back. Exiting a display while P.O. is selected will delete the point from the list. Going to the next point display "K2", shows a temperature of 20.0 and correction of 0.8 degrees. Temperatures that fall between -35.4 and 20.0 will get an interpolated correction applied to them. Temperatures that fall outside the points entered will get the correction of the outside point.

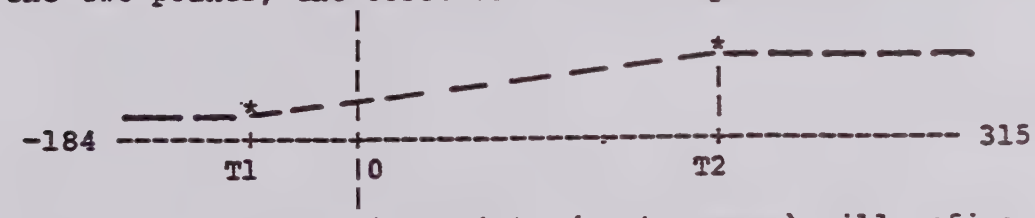
When exiting the last of the current points (here "K3"), display "L" appears. Display "L" and "M" allow entering a new correction point into the list. After entering the temperature of the point, using the UP and DOWN keys in display "L", go on to display "M" and enter the correction for that temperature. The correction range is -5.5 to 5.5 Celsius degrees. The temperature can be any within the full range of the controller, -184.4 to 315.5 degrees.

The procedure for entering the correction curve should be to first run the chamber without corrections, stopping at several setpoints that span the operational temperature range of interest. Record the readings of a dependable temperature standard in the chamber at the setpoints. Subtract the setpoint from the reading to get the correction to enter at the temperature equal to that setpoint. Enter the correction points and make a few checks with the temperature standard to confirm that all is well. See example below:

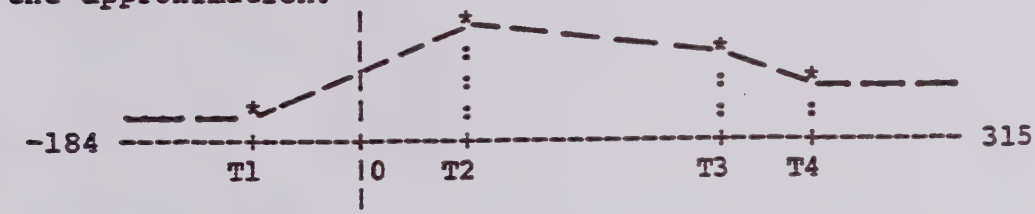
Entering one calibration point will shift all temperatures by the correction:



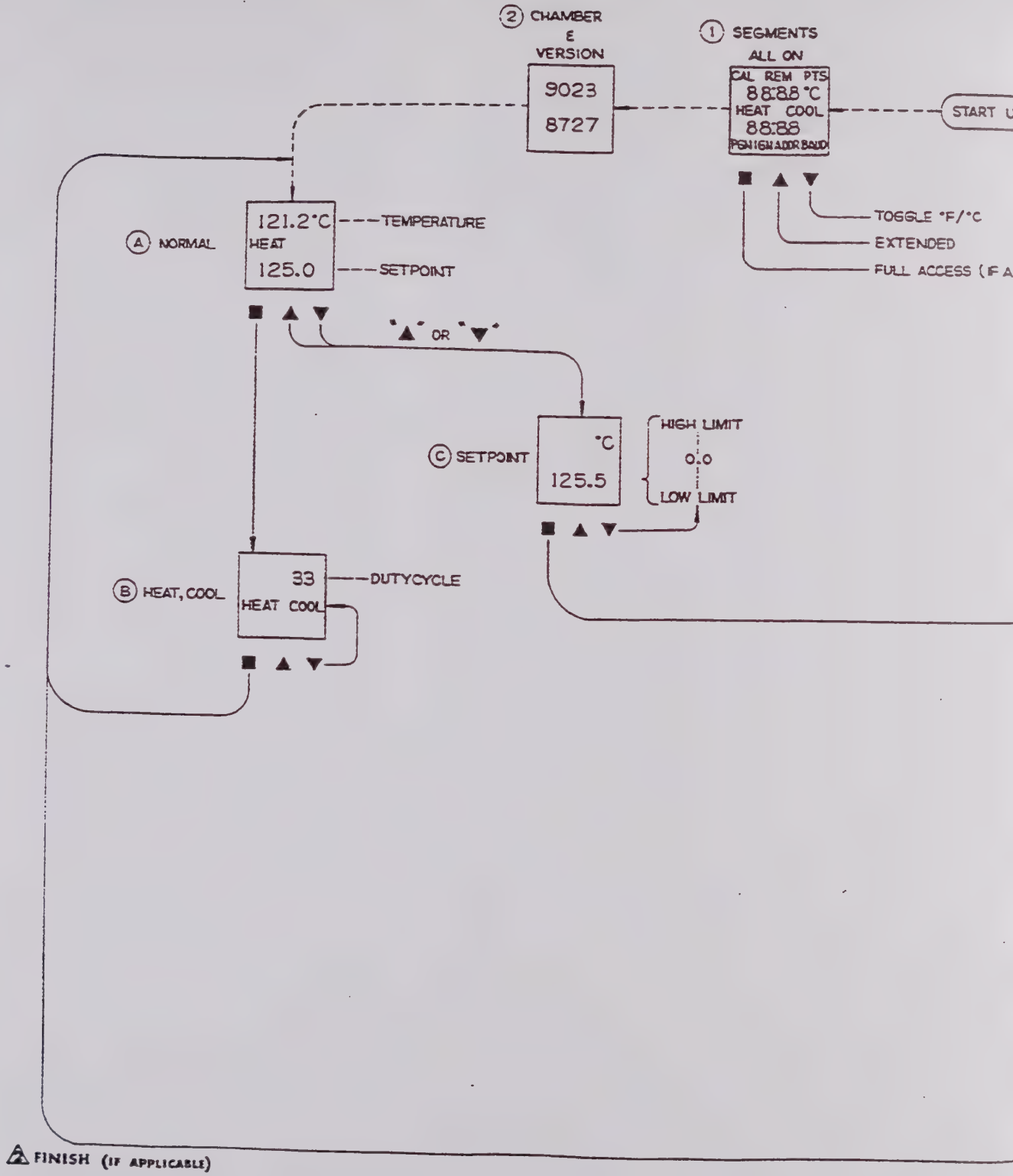
Entering two calibration points will extend the two corrections to the outer limits. For temperatures between the two points, the correction is interpolated:



Adding more calibration points (up to seven) will refine the approximation:



Notice that the points are reordered as points are added.



NOTES: UNLESS OTHERWISE SPECIFIED

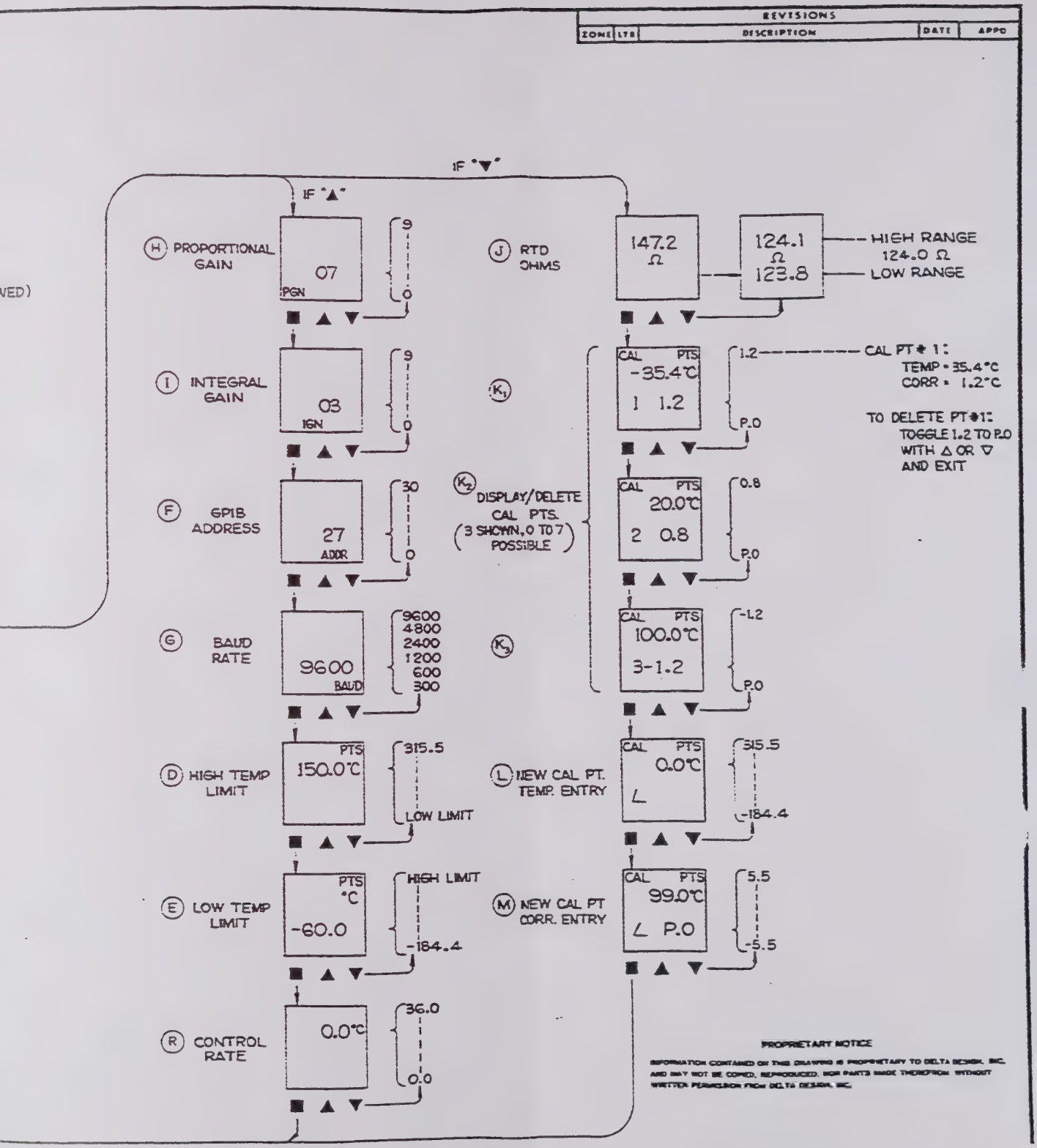


Figure 5-4. Full Access

5.6 FULL ACCESS, SW1-2 ON (Figure 5-5)

Switching SW1-2 to ON changes the access and operation so that either a list of setpoints or a rate program can be used. Front panel FULL access is used to enter the parameters, then any access level may be used to select from the list of setpoints, or start and stop the rate program.

5.6.1 LIST OF SETPOINTS

When the chamber is usually operated at a restricted number of temperatures, it may be more convenient to use this mode of operation. The setpoints that may be selected in display "C", are those that have been entered as part of the ten step rate program, that fall within the upper and lower temperature limits entered in "D" and "E". The list may be made secure, if necessary, by switching SW1-3 to ON. This disables FULL access from the front panel.

5.6.2 RATE PROGRAMMER

Figure 5-5 shows that the key sequence to get to the rate program step parameters (temperature, soaktime, rate) from the main display "A", is DOWN to "C", then FCN to S1. The figure shows just two, but as many as ten steps may be entered. The step number is shown in the lower left corner.

A new step can be entered after keying thru the existing list. A new step is added to the list when in display "V", the P0 is keyed out with the UP and DOWN keys, and the control rate entered.

When the program step parameters are all entered, the number of program repeats or passes may be entered in display "X". Rate program operation is enabled by making the number of program repeats greater than zero.

5.6.3 RATE PROGRAM OPERATION

Once the rate program is enabled by entering a non-zero value for the number of program repeats, the rate program can be started by keying down from display "A" to "B", and then to "P", with the FCN key. "P" will show the number of entered program repeats on the top, and 00 for the number of program passes so far completed on the bottom of the display. Pressing UP or DOWN to make the Omega sign appear and then exiting the display with the FCN key, will start the rate program at

step one.

The chamber temperature should be fairly stable and the HEAT and COOL enabled before starting the rate program. The chamber temperature at rate program start, will be used as the starting temperature which will be periodically incremented, so as to "walk" the temperature up to step one's target temperature. When the temperature reaches within one degree C of the set temperature, soak timing will begin. The set temperature will be replaced by the elapsed soak time in the main display "A".

At the end of the programmed soak time, signalled by the main display switching in the next step set temperature for the elapsed time, the chamber will be rate controlled to that new temperature.

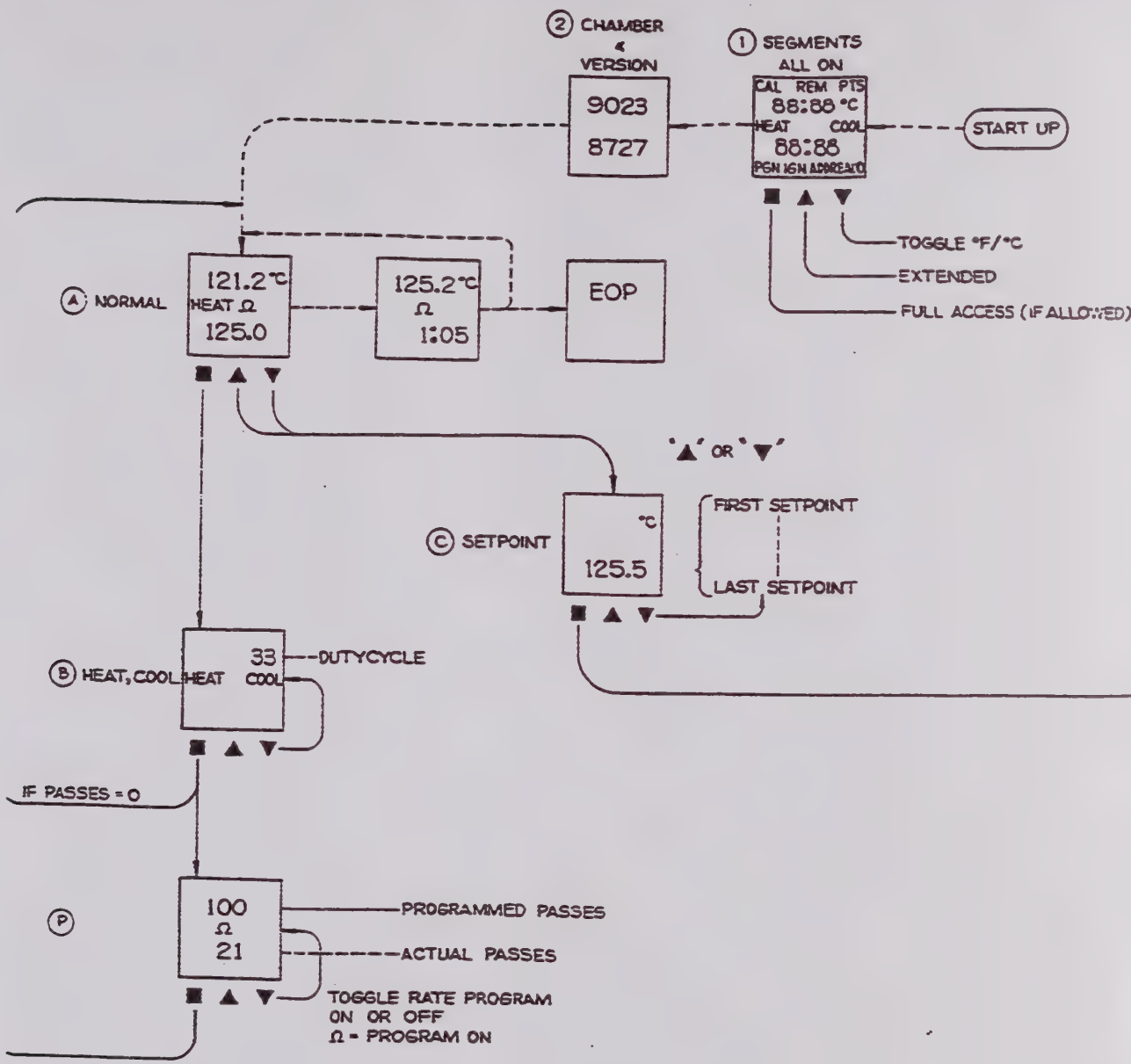
If it were the last step in the rate program, the number of passes completed would be incremented and step one used as the next step. The display EOP signals that the last pass of the program has been completed. HEAT and COOL is turned off. It is necessary to go to display "P" and toggle off the Omega symbol to get out of the rate program completely.

5.6.4 RATE PROGRAM NOTES

If a step has a soak time of zero, control will switch to the next step as soon as the chamber temperature reaches within one degree C of the set temperature. This can be useful to go part way to a temperature at some rate, and then the rest of the way at some other rate of temperature change.

If a step has a rate of zero, NO rate control will be in effect for that step and the chamber will go to the set temperature at its maximum rate. Permissable values for rate are 0.1 to 36.0 degrees C per minute. Actual chamber maximums vary, depending mainly on the model.

Once the rate program has been started, no changes can be made except to turn on and off the HEAT and COOL, and to stop the program. All other parameters may be viewed as the access level selected allows.



FINISH (IF APPLICABLE)

MATL (IF APPLICABLE)

UNLESS OTHERWISE SPECIFIED

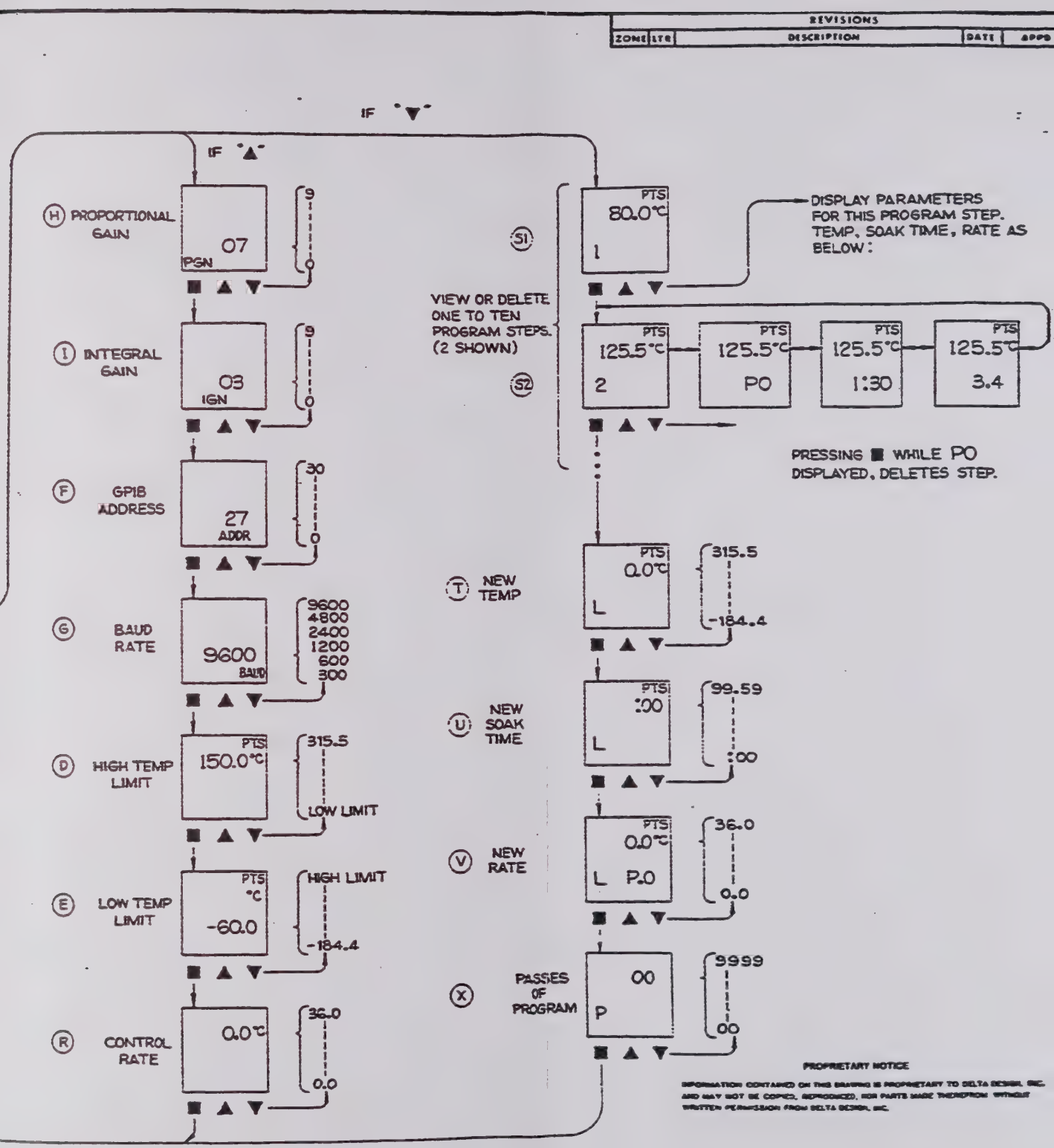


Figure 5-5. Full Access, SW1-2 ON

5.7 REMOTE OPERATION OF THE DELTA 9010

Operation of the 9010 can be done remotely using the two connectors on the rear of the chamber. One connector is for the IEEE-488 interface bus (commonly called the GPIB), and the other is for the RS-232C serial interface.

5.7.1 GPIB CONNECTION

A 9000 series chamber with a 9010 Temperature Controller may be part of a GPIB connected test system in which up to 15 instruments are controlled by a program in a GPIB control computer. A simple system consisting of the chamber remotely controlled by a Hewlett-Packard HP-85 will be discussed.

The command strings recognized by the 9010 are listed in Table 5-2. A short HP-85 program best illustrates how they are used.

```
100 Z = 727                    !THE ADDRESS OF THE 9010
                               ! INITIALLY IS 27.
150 CLEAR Z                    !HP TELLS THE 9010 TO
                               ! START FRESH.
200 OUTPUT Z; "S 123.4, HEAT ON"  !HP SENDS SETPOINT
                                  ! OF 123.4 DEGREES
                                  ! AND ENABLES THE
                                  ! HEAT CONTROL.
250 OUTPUT Z; "TEMP?"          !HP ASKS FOR THE TEMPERATURE.
300 ENTER Z; T1                !HP STORES THE 9010'S REPLY
                               ! IN VARIABLE T1.
350 OUTPUT Z; "Duty?,ST?"      !HP ASKS FOR THE DUTYCYCLE
                               ! AND STATUS.
400 ENTER Z; D1, S1            !HP STORES THE TWO VALUES.
450 WAIT 1000                  !PAUSE 1 SECOND.
500 DISP T1; D1; S1            !DISPLAY TEMPERATURE,
                               ! DUTYCYCLE, STATUS.
550 GOTO 250                   !LOOP FOREVER
999 END
```

1. Notice that there may be several commands in one line, as long as neither the command line nor the reply line exceed 132 characters.

2. A comma must separate the individual commands.

3. Case may be upper, lower or mixed. The commands may be shortened as noted in the list.

4. All commands that elicit a reply from the 9010 end with a question mark. The replies are always numbers, either integer or real.

5. While a GPIB program, for example the above, is running, the REMOTE annunciator on the front panel LCD will be on. It signals that front panel changes are inhibited while still allowing display of the parameters.

6. All remote temperature messages are in degrees C. Switching to Fahrenheit only affects the front panel interface.

5.7.2 RS-232C CONNECTION

The chamber has a standard 25 pin female connector with the following signals:

```
9010 Xmitr  -------> pin 3
9010 Rcvr   <------- pin 2
Always High -------> pin 6
Signal Gnd  -------- pin 7
```

The RS-232 expects data with 8 bits, no parity, 2 stop bits. The rate is selectable from the front panel. Initially, it is 9600 baud.

Command of the 9010 thru the RS-232 can be either by terminal or by computer. On power-up, the 9010 is in the computer mode. In this mode there is no echoing of commands and no prompting. The program should send commands from the list as in the GPIB example, and be able to handle the replies. If the computer serial interface is compatible with the above signals (as is, for instance, the IBM PC), then a straight-thru connecting cable can be used.

Operating directly with a terminal only requires that the terminal be setup for duplex operation, with a baud rate matching the 9010. On power-up of the 9010, type in the letter "M" and press "return". The 9010 prompt of "MON>" will appear indicating that the mode has been toggled from computer to terminal. Commands from the list may be typed in, and are sent when the "return" key is pressed. The backspace key can be used to make corrections in the command line.

An example session using a terminal follows:

```
Type M <cr>          ... Puts 9010 in the terminal mode.

MON>                 ... The prompt appears.

MON>callen?<cr>      ... Send the command to get the number of
                             pts in list.
   3                 ... Reply is length of list - 3 pts.
MON>                 ... Prompt reappears after each command
                             is completed.

MON>Set 123.4<cr>    ... Send command to change the setpoint.
MON>                 ... No reply, prompt reappears.

MON>heat on, cool on,Temp? <cr> ... Send 2 action commands
                                        and 1 query.
   88.8              ... Reply is temperature in C.

MON>HISET? <cr>      ... Send misspelled command.
?! ?                 ... Command not recognized.
MON>                 ... 9010 ignores misspelled command.
```

TABLE 5-2
LIST OF REMOTE COMMANDS AND QUERIES

Version?	Program version - year and week of year.
Setpoint ddd.d	Setpoint temperature to tenth degree C.
Setpoint?	Get the setpoint temperature.
Temperature?	Current measured temperature.
Heat ON <OFf>	Enable <disable> the heat control.
Cool ON <OFf>	Enable <disable> the cool control.
HIghset ddd.d	High temperature limit to tenth degree C.
HIghset?	Get the High temperature limit.
LOwset ddd.d	Low temperature limit to tenth degree C.
LOwset?	Get the Low temperature limit.
Dutycycle?	Current Dutycycle in percent.
CORrection?	Calibration correction for current temp.
STatus?	9010 status word - a three digit number.
Xrate dd.d	Control rate to tenth degree C / min.
Xrate?	Get the Control rate. 0.0 to 36.0
Pgain n	Proportional gain number. 0 to 9
Pgain?	Get the Proportional gain number.
Igain n	Integral gain number. 0 to 9
Igain?	Get the Integral gain number.
Mon	Toggle RS-232, terminal or computer mode.
Output ON <OFf>	Turn on <off> Out3 at J10-1.
CALpts T1,C1 <,T2,C2>	Enter one <or list> of calibration points.
CALpts?	Get the list of calibration points.
CALClear	Clear all cal points on the list.
CALDelete n	Delete from the list the nth cal point.
CALLength?	The number of valid cal pts in the list.
REMote	Front panel changes disabled.
LOCal	Return control to the 9010 front panel.
New Warm <Cold>	Reset. Zero <do not zero> the Saved RAM.
DEgrees Celcius <Fahrenheit>	Front panel degree select.

TABLE 5-2 (CONTINUED)
RATE PROGRAMMER COMMANDS

STEp n,ttt.t,ssss,rr.r	Enter temp, soaktime and rate for step n.
STEp? n	Get temp, soaktime and rate for step n.
STEMp n, ttt.t	Enter the temperature for step n.
STEMp? n	Get the temperature for step n.
SSoak n, ssss	Enter the soaktime in minutes for step n.
SSoak? n	Get the soaktime for step n.
SRate n, rr.r	Enter the control rate for step n.
SRate? n	Get the control rate for step n.
STEPClear	Clear list to one setpoint.
STEPCOunt?	Get the number of valid steps in the list.
STEPNumber?	Get the current step in the program.
STATE?	Get the rate program state. 0 - 3
SOAktime?	Get the current time soaking in minutes.
PAsscount nnnn	Enter the number of rate program repeats.
PAsscount?	Get the number of rate program repeats.
PASsnumber?	Get the current pass being executed.
PROGram Begin <End>	Begin from step 1 <stop> the rate program.

TABLE 5-3
THE COMMAND LIST

COMMAND	
Version?	Get version number (year,week), ie: 8727. This is the same number that appears on the LCD at power-up.

The ^s (carets) highlight the necessary command characters, the other letters are optional. In this case the simple command "V?" would suffice. "VERSION?", "Ver?" and "v?" are also acceptable. "Ver ?" and "Version" are not acceptable and will be ignored. The question mark is required and cannot be spaced from the command word.

In response to this query, the 9010 will send back a number such as "8727". This number identifies the program version with the date: the 27th week of the year 1987.

Note that ALL replies to queries are numbers, either integer or real in the form of a string of ascii characters terminated by CR and LF characters. This is true whether communicating thru the RS-232C via a dumb terminal or by computer, or thru the IEEE-488 interface.

COMMAND	
Setpoint ddd.d	Set setpoint temperature (Lowset to Highset). The setpoint must be within the limits to be accepted.
Setpoint?	Get the setpoint temperature.
Temperature?	Get temperature (-200 to 327.5 deg C). This is the temperature after correction by the curve formed by the calpoints.
Heat ON	Enables the heat control.
Heat OFf	Disables the heat control.

TABLE 5-3 (CONTINUED)

COMMAND		
Cool	ON	Enables the cool control.
Cool	OFf	Disables the cool control.

A short program using the above commands will illustrate their use. If an HP-85 computer were loaded with this HP Basic program and connected via the GPIB to the 9010 temperature controller, the following would occur: The REMOTE word turns on at the top of the LCD as soon as the program is started. The setpoint display changes to 123.4 and the HEAT word turns on in the LCD. Assuming the chamber was at room temperature, it will heat up while the computer monitors the temperature. When the temperature exceeds 100 degrees C, the Heat is turned off and the program ends. REMOTE goes off and control is returned to the front panel.

```
100 OUTPUT 727;"SET 123.4"          !GPIB address = 27.  Set-
                                    ! point temp = 123.4 deg C.
110 OUTPUT 727;"Heat ON, Cool ON"   !Enable heat and cool
                                    ! control.
120 OUTPUT 727;"Temp?"              !Request the current
                                    ! temperature.
130 ENTER 727; T1                   !Get it, save in real
                                    ! variable.
140 WAIT 1000                       !Pause 1 second.

150 IF T1 < 100 THEN GOTO 120       !Loop til temp reaches 100
                                    ! deg C.
160 OUTPUT 727;"H off, C off"       !Then disable the heat and
                                    ! cool.
170 END
```

The command in statement 100 could have been "S 123" as one space is required, but more are allowed between the command word and the associated numberic. An integer may be used and will be treated as 123.0. Here the setpoint value is imbedded in the string, but it may be necessary to extract the ascii from a program variable. In BASIC for instance, the command might be:

CMD$ = "Setpoint " + STR$(stemp) where the STR$ function converts the setpoint variable to ascii.

TABLE 5-3 (CONTINUED)

Similarly it may be necessary to convert the number reply from ascii to real. HP Basic does it in the ENTER statement but other GPIB implementations may only get the reply as a string variable.

In statements 110 and 160 two commands separated by a comma were sent. Any number of commands and queries may be so combined, as long as the command string and the reply string elicited, does not exceed 132 characters. The replies will be separated by commas in the order of the queries.

COMMAND	
HIghset ddd.d	Set high temp limit (LOWSET to 315.5 deg C). This sets the upper setpoint limit. Also, at temperatures 5 deg C above the Highset, both heat and cooling will be turned off.
HIghset?	Get high temp limit. This sets the lower setpoint limit. Also, at temperatures 5 deg C below the Lowset, both heat and cooling will be turned off.
LOwset ddd.d	Set low temp limit (-184.4 to HIGHSET).
LOwset?	Get low temp limit.
Dutycycle?	Get the dutycycle (-100 to 100). Cooling full on is indicated by -100, while -40 would mean it is cooling with 40% of full on.
CORrection?	Get correction for current temperature. Subtracting this value from the temperature will give the raw temperature reading.

TABLE 5-3 (CONTINUED)

COMMAND		
STatus?		Get the status word, a 3 digit number: sta.
	s: 0	Dutycycle less than 100% and error less than 2 degrees C.
	1	Error greater than 2 degrees C.
	2	Dutycycle at 100%.
	3	Error greater than 2 degrees C and Dutycycle at 100%.
	t: 0	Temp within the High and Low Limits.
	1	Temp greater than High Limit.
	2	Temp less than Low Limit.
	3	A/D Converter underranged.
	4	A/D Converter overranged.
	a: 0	Both Heat and Cool are enabled.
	1	Heat is disabled.
	2	Cool is disabled.
	3	Both Heat and Cool are disabled.
Xrate dd.d		Control rate from 0.0 to 36.0 degrees C per minute. When not zero, the 9010 will try to step up to the setpoint at that rate. When the rate is 0.0, no rate control is in effect.
Xrate?		Get the Control rate.
Pgain n		Set the proportional gain number (0 to 9). Increasing numbers double the gain.
Pgain?		Get proportional gain number.
Igain n		Set integral gain number (0 to 9). Increasing numbers double the gain.
Igain?		Get integral gain number.

TABLE 5-3 (CONTINUED)

COMMAND	
Mon	Toggle RS-232 mode, terminal or computer. Used mainly to switch to terminal mode after power-up.
Output ON	Causes the open collector line at J10-1 on the main PC board to go to GND.
Output OFf	Causes the open collector line at J10-1 on the main PC board to be not GND.
CALpts ttt.t, c.c	Insert points (temp,corr) in the list of 7. One or more points can be entered until the list has 7 entries. No further entries will be accepted until the list is cleared or a point deleted. The list is ordered by temp.
CALpts?	Get all points in the list. The reply is a list of 14 values separated by commas. All after the number of points entered (given by CALLen below) will be 0.0, 0.0 .
CALClear	Clear all points in the list. Set the number of points to zero and zero all the points.
CALDelete n	Delete from list the nth point. Take out the nth point and reorder the list.
CALLen?	Get the number of points in the list. Returns the number of valid points in the list.

TABLE 5-3 (CONTINUED)

COMMAND	
REMote	Put the 9010 in the remote mode.
LOCal	Return control to the front panel.
New Warm	Reset, clear all RAM except the parameters.
New Cold	Reset, clear all RAM and the parameters. Load the initial values of parameters.
DEgrees Celcius	Select the front panel interface to be in C.
DEgrees Fahrenheit	Select the front panel interface to be in F. (The remote communications is still in C.)

5.8 RATE PROGRAMMER COMMANDS

The following commands are used to program a ten step program that may be repeated 9999 times. Each step consists of a target setpoint, the time that the chamber will be held at that setpoint, and the rate at which the temperature changes from the current temperature to the setpoint.

Once a passcount is entered. the program may be started.

5.8.1 SETPOINT LIST

The list of temperatures in the rate program can be used for setpoint selection from the front panel. If only a few specific setpoints are normally used, this may be a preferred mode of operation. Dip switch SW1-2 on the main 9010 PC board must be ON to use this list.

TABLE 5-4
RATE PROGRAMMER SETPOINT LIST

COMMAND	
STEp n,ttt.t,ssss,rr.r	Enter temp, soaktime and rate for step n. Time in minutes, rate in degrees C / min.
STEp? n	Get temp, soaktime and rate for step n. The reply string is "ttt.t, ssss, rr.r".
STEMp n, ttt.t	Enter the temperature for step n.
STEMp? n	Get the temperature for step n.
SSoak n, ssss	Enter the soaktime in minutes for step n.
SSoak? n	Get the soaktime for step n.
SRate n, rr.r	Enter the control rate for step n.
SRate? n	Get the control rate for step n.
STEPClear	Clear list to one setpoint. All ten steps are zeroed with the exception of step 1. The temperature value in step 1 is saved.
STEPCOunt?	Get the number of valid steps in the list. Reply is a number from 1 to 10.
STEPNumber?	Get the current step in the program. Zero (0) until the rate program is running.
STATE?	Get the rate program state. 0: Program not running. 1: Running to the setpoint temp. 2: Soaking at the setpoint temp. 3: Program has ended.

TABLE 5-4 (CONTINUED)

COMMAND	
SOAktime?	Get the current time soaking in minutes. Zero (0) while not at the step setpoint.
PAsscount nnnn	Enter the number of rate program repeats. 1 to 9999 repeats must be entered before the program can be started.
PAsscount?	Get the number of rate program repeats.
PASsnumber?	Get the current pass being executed. Zero (0) while program not runnings.
PROGram Begin	Begin the rate program from step 1. Heat and cool are enabled, the set-point from step 1 as well as the control rate is entered. The OMEGA sign appears on the LCD to indicate that the 9010 is running the rate program.
PROGram End	Stop the rate program. Both heat and cool are disabled, the OMEGA sign goes off.

5.9 MAINTENANCE

5.9.1 TEST MODE

This mode should only be activated by maintenance personnel. When DIP switch SW1-1 on the main board is in the ON position, none of the previous modes apply; a special test program runs instead.

NOTE

During this test all output lines are toggled. To avoid cool solenoid chatter and heat turn on, temporarily disconnect J9 and J10 and J4 on the Aux Module PCB.

On startup the LCD will show all the annunciators (the non-digits) and either "7777" or "----" for both the four digit displays. The "7777" indicates that the RAM test passed; "----" that it failed. The test program does not use the RAM. Pressing the UP key will cause all digits to step up thru the "B" code (0, 1, 2, 3, 4, 5, 6, 7, 8, 9, -, E, H, L, P). Pressing the DOWN key steps down thru the "B" code. Pressing the other key will toggle the annunciators off and on.

Connecting a terminal (set for 9600 baud) permits further testing. On start up "ROM only 1/87" appears on the terminal, followed by a report on the RAM test. Pass or fail the program then goes into an endless loop sending ".+.+.+.+.+.+.+.+.+.+.+...." to the terminal until the program is stopped. The "+" will be replaced by any printable key pressed on the terminal, to check both directions of communication over the RS-232C lines. In addition, the four output lines are toggled independently.

5.9.2 ANALOG CIRCUIT

It was mentioned in Section 5.5.2 that display "J", that appears just before the calibration displays, could be used to investigate the health of the RTD sensor circuit. It shows the resistance in ohms of the 3-wire platinum RTD connected at TB1.

The RTD is 100.0 ohms at 0 (zero) degree C and 138.5 ohms at 100 degrees. The can measure between 20 and 220 ohms connected from TB1-1 to 2 with a jumper from TB1-2 to 3.

Pushing the UP and DOWN keys switches in a test

resistor and switches into either the High or Low range of the sensor circuit. The 124 ohm test resistor falls in the overlapping portion of the two ranges. The High reading and the Low reading of the test resistor should agree within 0.2 ohms, and neither should differ more than 0.2 ohms from 124.0.

If pressing UP and DOWN again makes the High and Low closer, but they are still too far from the 124.0 value, the bridge circuit has probably become unbalanced. The trimpot R4 is set at the factory and should not need periodic adjustment.

The "J" display can only be exited by pressing the FCN key. The sensor circuit will then be switched back to normal.

5.9.3 CLEARING ALL RAM

The back-up circuit and three volt lithium battery keep the low power CMOS Random Access Memory alive when power is off. On power-up, this RAM is cleared to zeros except for a portion in which the operating parameters are saved.

If for some reason this section gets polluted, there is a way to clear all of RAM to zero, and then load in nominal initial values for the parameters. At the front panel, with the power off, hold down the FCN, UP and DOWN keys with one hand and press the ON key. The display will blank out until the three keys are released, then it will go thru its normal start-up sequence.

If the battery back-up fails, a similar sequence will be seen during start-up.

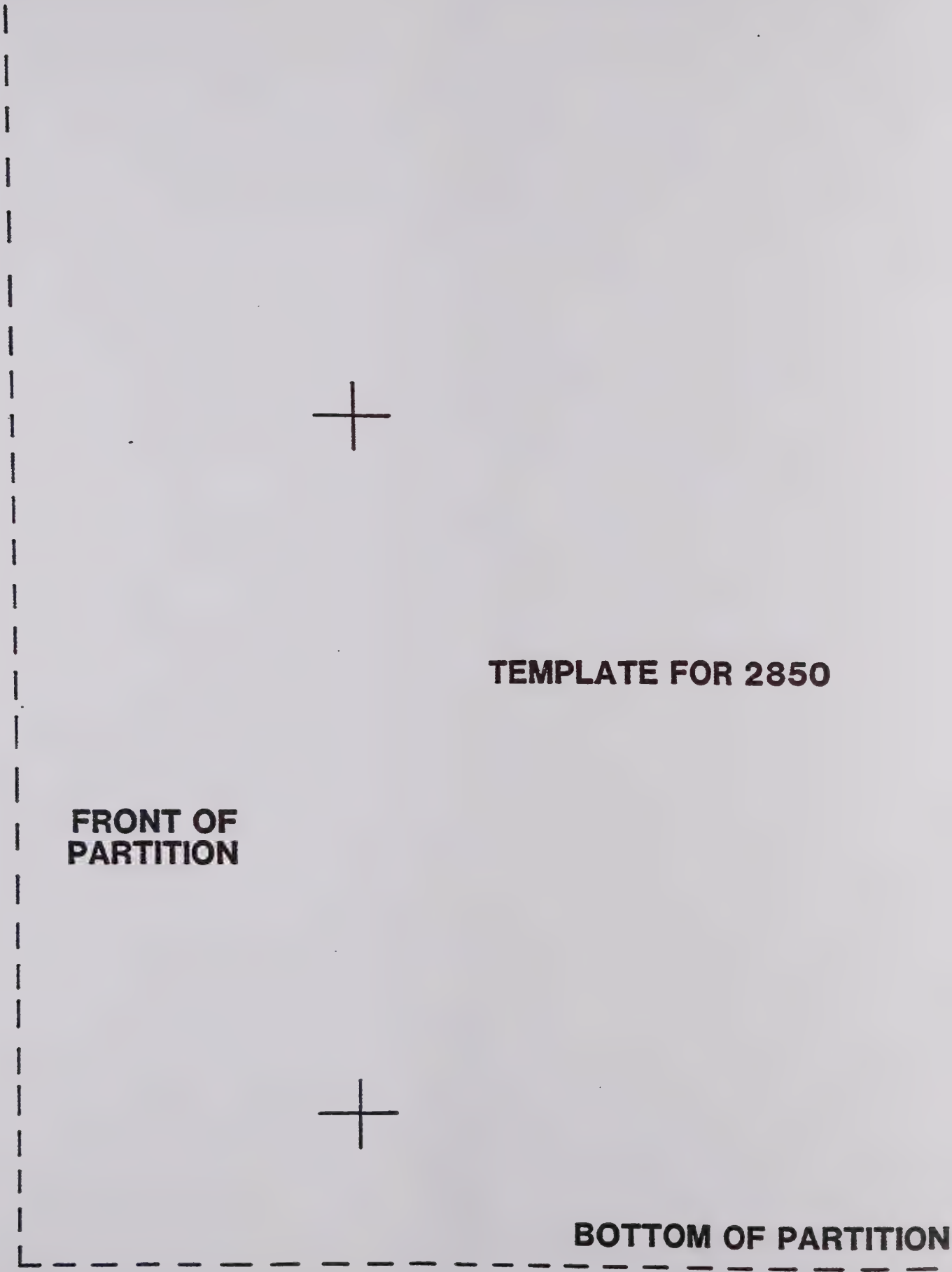
5.9.4 -HI- OR -LO- DISPLAYED

These two displays indicate trouble in the analog section. The RTD, the sensor circuit or the A/D converter are suspect.

BOTTOM OF
PARTITION

FRONT OF
PARTITION

TEMPLATE FOR 2300


TEMPLATE FOR 2850
FRONT OF PARTITION
BOTTOM OF PARTITION

TEMPLATE FOR 390

BOTTOM

BACK OF
PARTITION

F PARTITION

TEMPLATE FOR 59

BACK OF
PARTITION

BOTTOM OF PARTITION

TEMPLATE FOR 64

BACK OF
PARTITION

BOTTOM OF
PARTITION

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